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POWER

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Electric Power

PRESIDENT Glenn Frank of the University of Wisconsin, in an address at the Chicago Power Conference and more recently in speaking to the American Bankers Association, looks to electric power for the decentralization of industry.

He says that we are today in a twilight zone between an old machine industry that rested upon steam power and a new machine industry that will rest upon electric power.

Of course, "electric power" is for the most part steam power transmitted by electricity.

The electric generator is not a prime mover. A little electricity is produced by primary batteries, but the production of electricity in large quantities directly from fuel is still an *ignis fatuus* for the inventor and electronic power, or the extraction of power from the atom, although recognized as possible, awaits a demonstrator.

And so, for some time to come probably, we shall be dependent upon those processes that transform the potential energy of fuel to kinetic energy in the flying molecule and then, on the piston of the engine or the blade of the turbine, change this molecular momentum into useful work.

What electricity has done is to furnish a simple and easily controllable means for distributing this power.

And, as President Frank says, this may easily lead in the direction of a decentralization of industry.

I remember when a small shoe-pegging shop was an appurtenance of many a New England farm; the women folks added to the family income by sewing gloves for the factories in neighboring villages.

With cheap available power it would appear that many industrial processes might be so distributed, affording to a rural population profitable employment, either at home or at smaller factories away from the crowded and harassing conditions of industrial centralization.

But most products involve group or continuous manipulation and some expert oversight, and it will be long before the complicated and interlocking processes of many industries resolve themselves into home work.

A factor that will operate in the direction of centralization is the fact that in the process of producing power from steam a large proportion of the high velocity that has been given to the molecules to produce pressure and superheat remains unconverted in the exhaust.

Under modern conditions this exhaust may be delivered at any pressure and temperature desired and this residual heat extracted in heating and manufacturing processes.

And in this way the heat utilization may be increased from the less than 20 per cent of the condensing engine or turbine to near completion. This can obviously be done only when complementary processes are closely grouped.

F. R. Low

Stokers or Pulverized Coal?

CHOICE between pulverized coal and stoker firing is not easy. Many aspects of the question have to be considered. The decision of the Detroit Edison Company to use stokers in its new plant, reported on another page of this issue, is a splendid illustration of the complexity of the question. With many years of successful stoker operation and several years of satisfactory pulverized coal burning, the company was in a position to balance the comparative merits of the two systems with full information. Mr. Parker, the chief engineer, gives the salient facts and tells why the decision was made.

That the choice was based on ash disposal is a striking instance of the influence of seemingly insignificant things.

And does it not prove that pulverized coal has "arrived?" With only a few years of service behind it, this new idea in the power plant has been developed to a substantially equal standing with the stoker, which has a far longer pedigree. With sound engineering, a good job can be done either way, and a choice is to be made only after full consideration of every detail of plant operation. Little things count.

How About the Man?

"LET the Machine Do It," said the editor, in the April tenth issue, and a reader replied, "How About the Men?" A fair question, this—and F. M. Reiter's letter in this issue is worth careful study. The question he raises is an old one and has been the subject of many hot debates, not always supported with figures as carefully chosen as Mr. Reiter's.

While the editorial sang the praises of machines on the immediate grounds of the manufacturer's self-interest, *Power's* editors are fully convinced that mechanization is by no means on the defensive as far as the public welfare is concerned—quite the contrary. Some questions of adjustment remain to be solved, but it has been proved that the workingman generally gains far more than he loses when machine replaces brawn.

Look back over the past fifty years and note how closely the prosperity of the average American has followed the growth in the use of machines. Then check the conditions of workers in various countries with the degree of technical advancement, making due allowance for other factors. Such comparisons indicate strongly that the machines which displace labor help labor—a strange paradox, but true.

These are the facts. To understand the *why* one must back away from the trees to get a look at the whole forest. The observer at one point merely sees a machine go in and some men go out. If he could rise up a thousand miles and look at the whole country, he would see first a lowered cost of the product made with the aid of the machine. This lowered cost he would observe being transferred into an extra penny or two in countless consumer's pockets all over the United States. He would see these pennies swelling the funds spent for autos, radios, clothes, etc., enough to create new employment to the men displaced by the machine.

If this all sounds like theory, remember Henry Ford, who displaced thousands of men by machines and yet gave employment to increasing thousands in his own plants and elsewhere because lower production costs reduced the price of cars.

Why, then, are fewer employed in industry than formerly? Simply because many of the jobs created by released consumer dollars are outside of the strictly "industrial" classification upon which Mr. Reiter's figures are based. Some of those boys who used to work in the factory are employed in filling stations, barber shops, road houses, hotels and other appurtenances of an enriched community. And some are living off of their surplus. Prosperity is not measured by the number employed in any arbitrarily limited group of industries, but by the ability of the average citizen to satisfy his demand for the necessities and comforts of life.

Is Spare Equipment Worth the Cost?

HAS too much attention been given to over-all efficiency of power plants and not enough to dollar efficiency. Many engineers are of the opinion that the answer to this question is "Yes." An interesting side light has been thrown on this question by the suggestion of a prominent industrial engineer. He urges that the cost of the power plants be reduced by not providing space capacity to insure one hundred per cent continuity in service. The contention is made that there are many industries where a temporary postponement of production can be permitted without incurring any loss or increased cost of production.

There are many arguments in favor of this suggestion, but this question must be answered first: Is it possible to have shutdowns without increased cost even if production can be made up after the power service is restored? If production were on a strictly piece basis this might be true, but few industries operate in this way. Another question, equally important, is this: Will the plant where an occasional interruption is tolerated be operated as efficiently as the one where one hundred per cent service is expected?

This is something to be carefully considered, since a loss in efficiency can easily outweigh any capital costs for spare equipment.

Fair Prices and Fair Play

IT IS an axiom of business, too often honored in the breach, that where the seller losses, the buyer will also ultimately lose. This applies more truly to the power field than to many other lines of endeavor.

Regardless of which side presses the contract through to signature, when a public utility agrees to sell current to an industry at less than cost, it is the buyer who eventually loses most. For he comes to base his manufacturing operations on a fictitious power cost, one that cannot be maintained; and when the central station is compelled to raise its price to him, as it unquestionably will be after a few years, then, whether he continues to purchase his power or begins to generate it himself, the cost structure of his business is overthrown. Years of sales effort, based on one cost of manufacture, must be discarded. A new sales campaign, on a new basis, must be undertaken, with success uncertain.

It would seem, therefore, to be the poorest sort of bargain for a manufacturer to obtain power from a utility at too low a cost. Let both parties stick to fair prices and fair play, and they will both be better off in the long run.

Welding Waterwheels to Meet Steam Competition

COMPETITION between steam stations and water-power projects is getting keener. A demoralized mining industry has kept coal at a low price level. Overproduction has ruled in the oil fields, with resulting low prices in districts where it is available for fuel. The fuel energy needed to produce a given amount of power has been cut about one-third in the last six years, with practically no increase in the cost of plant construction.

Water power is not so favored. Many of the sites that are near load centers have been developed, and the best locations for low-cost installation utilized. These conditions both tend to increase the cost of future water-power developments. In addition, waterwheel efficiencies now closely approach the limit. Improved efficiency therefore offers little hope for reduced costs. There is also a tendency on the part of state governments to place a tax on hydro-electric power and not tax power produced by steam stations.

These are some of the conditions to be faced in water-power development. It is handicapped at the start and must compete with the steam plant on an economic basis. New ways to reduce costs must be sought.

Makers of waterwheel generators have been replacing castings by welded structures. Weight has thereby been cut about a third and the cost reduced. Lighter generators permit savings in cranes and power houses.

The waterwheel manufacturers, on the other hand, have largely retained the cast structure for their machines. Where plate buckets are used, they are cast into the crown plate, and band and plate-steel casings are generally riveted.

The problems to be met in building waterwheels differ from those encountered in the frames of generators, so that it may be impossible to substitute fabricated structures for castings in all parts. However, the good results obtained from welding in electrical structures naturally leads to the question, "Why not the waterwheels?" It may help to meet the present competition.

Smoke Reduction Begins at Home

PROFESSOR PARR, president of the American Chemical Society, at their recent meeting in St. Louis, remarked that the smoke nuisance is growing in our cities, largely due to the unregulated operation of household stoves and furnaces. He suggested that gas may ultimately drive coal from the field, for economic and sanitary reasons.

The unintelligent burning of coal costs far more than most people realize. Not only is the thermal efficiency low, but the damage done by soot and smoke is undoubtedly great, although it is difficult to get dependable statistics. Laundry bills are increased. Perhaps health may be impaired—on this the doctors seem to disagree. The esthetic "kick" that comes to citizens of a really clean city is lost.

The solution almost always proposed by those concerned with public questions is the change to another fuel, such as coke, oil or gas. This is not the way the problem is tackled in the power plant. The fuel must be accepted as it is. The remedy for smoke is more intelligent design and operation. Can these be developed sufficiently to meet the problem in soft coal communities?

The design of a house-heating furnace that will burn soft coal smokelessly and efficiently and at the same time be cheap enough to fit the purse of the ordinary householder, is not an easy task. And the education of millions of women, who do most of the furnace tending, to an understanding of the task entrusted to them may be even more difficult. Perhaps a change of fuel is the best solution.

Coke does the trick nicely, but its successful use requires so complete a change in the methods of handling the equipment that some people, ignorant of how to handle it, have found it unsatisfactory. That it can be used with complete success in some, if not in all, types of household furnaces has been demonstrated beyond doubt, and in many respects it is the best fuel of all.

Oil presents certain advantages, but on broad economic grounds its use is open to some question. Its present high cost and its probable higher cost in years to come are but a reflection of the fact that oil has higher uses than as a domestic fuel.

Gas is better than oil in some respects. Those who have used gas for heating their homes are enthusiastic for it, despite its present cost, which is far higher than that of coal. On broad economic grounds the use of gas is to be encouraged. With the development of better methods for carbonizing coal, that recover its higher chemical values for the uses for which they alone can supply adequate raw material, there is likelihood of an increasing supply of gas and coke. Is there not a possibility of developing a system of gas distribution in the more densely populated centers at a price that will make it the universal fuel, and of selling the coke beyond the limits of that concentrated gas-burning region? Thereby might be set up a balance of uses that would extract from our coal its separate constituents, devoting each to the highest use for which it is adapted, and at the same time going a long way toward the elimination of smoke.

Rub Off the Oil and Grease

SPEAKING epigrammatically, a well-known business authority recently remarked that one of the factors contributing to present conditions in New England would be revealed "if the oil and grease were rubbed off the nameplates of industrial machinery." That many obsolete plants, including power generating and service equipment are to be found in this section is probably traceable to its early start as a manufacturing center, to local conservatism, absentee ownership and economic conditions that have prevailed in the textile field during the last few years.

The indictment applies not alone to New England, as obsolete equipment, to a lesser degree perhaps, will be found in other sections.

To the ultra-conservative mind the fact that a machine continues to give satisfactory service, is not worn out and is as efficient as the day it was installed, coupled with the fact that the investment has been entirely written off, is sufficient reason for its retention. Such individuals do not grasp the tremendous strides that have been made in power-plant practice during the last few years—improvements which, by reason of their performance, render much of the old equipment a liability, regardless of how well it may function. That modern equipment intelligently selected will usually pay for itself in two to three years, sometimes less, is attested by the many cases reported in technical literature of the last two or three years.

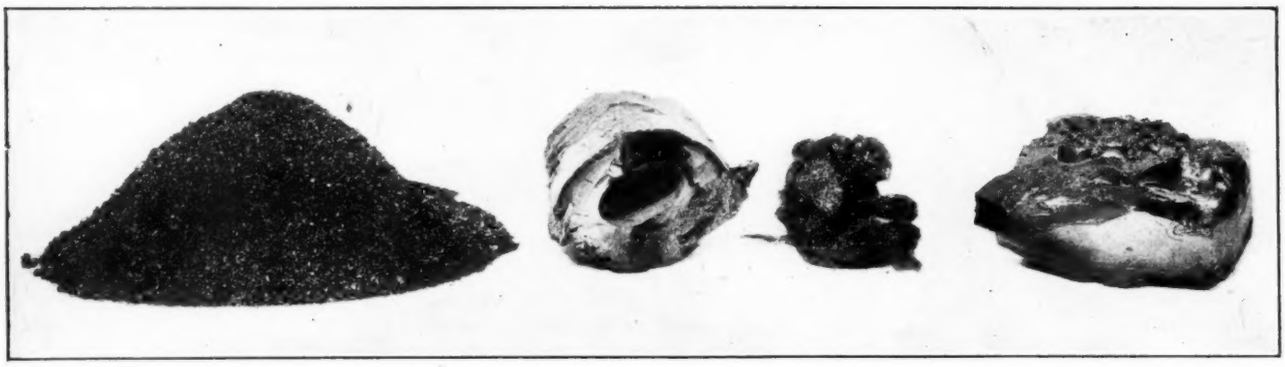

Fig. 1—Left, granular slag from sluice discharge; left center, slag tube formation; right center, mineral or slag wool; right, solid block of slag

Removing Molten Ash
By Hydro-Jet System

From slagging furnaces at the Charles R. Huntley Station, Buffalo

By Donald H. Scranton

Engineer with Buffalo General Electric Company

AMONG the innovations in connection with the installation of the pulverized fuel burning boilers at the Charles R. Huntley Station[1] of the Buffalo General Electric Company, was the Hydro-Jet system of ash removal applied to the disposal of molten ash, where comparatively low-fusion-ash coals are being burned. The following describes the conditions that had to be dealt with in arriving at a satisfactory solution of the ash-moving problem.

All four of the new boilers erected during the recent extension of the station were of the B. & W. cross-drum type, 44 wide and 11 high, containing 12,500 sq.ft. of boiler heating surface. Each boiler is provided with a separate economizer.

The furnace under the first boiler included a well 8 ft. square and 11 ft. deep, sunk into a furnace floor that was 17 by 25 ft. and averaged 12 ft. 9 in. to the bottom row of boiler tubes. The sides of this well were formed by 3½-in. tubes on 6-in. centers covered on the fire side with solid calorized steel Bailey blocks. At the top of the well these tubes were bent outward at an angle and ran through the furnace, uncovered, to headers on the outside of each wall. The well floor was constructed of carborundum tile covered by blocks of the same material. The bottoms of these tile formed the roof of a plenum through which the secondary air entered the furnace, flowing in back of the well tubes. No water tubes were installed in this floor. The general construction is shown in Fig. 3.

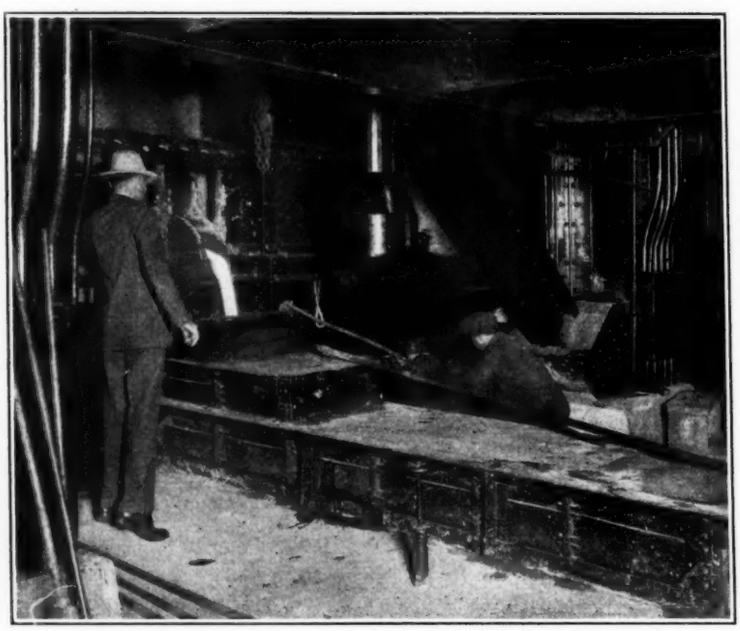

Fig. 2—Slag spout in service

Burners were set in each wall halfway between the furnace center line and right-hand adjacent wall, in such a manner as to create a rotating effect when in operation.

It was at first expected that the cyclonic effect in the well would keep it free from ash and that the ash would drop out as the gas expanded into the main furnace above the well. However, it soon became apparent that bare blocks would not stand up under the high

[1] A general description of this station appeared in *Power*, Nov. 22, 1927, pages 775 to 780.

combustion rate of 1,100,000 B.t.u. liberation per cubic foot of well volume, equivalent to 62,000 B.t.u. per cubic foot of combined furnace and well volume.

Subsequent changes in the well blocking in which the calorized steel blocks were replaced with refractory-faced Bailey blocks and the sloping well tubes above the well covered with clay tile, served to increase the furnace temperature to the point where the ash became molten and dropped directly, or ran from the clay tile, into the well. This increased temperature reduced the carbon carry-over and improved combustion generally.[2] That portion of the slag which ran down the clay tile banks on the sloping tubes continued downward into the well, flowing on the face of the wall. Upon reaching the floor the accumulation took the form of a pool, remaining in the molten state because of the high temperature of the furnace above and the absence of cooling tubes below. This fluid could be readily tapped through a hole in the bottom portion of the well, but the greater problem was to find some satisfactory means of disposal once this material was withdrawn from the furnace.

To give a better picture of the problem, the following analyses of coal and slag are given, together with a few of the characteristics of the slag:

Coal (Dry Basis)	Per Cent	Slag Analysis	Per Cent
Fixed carbon	53.29	Silica (SiO_2)	44.52
Volatile matter	34.66	Aluminum oxide (Al_2O_3)	18.64
Ash	12.05	Iron oxide (Fe_2O_3)	31.35
Sulphur	2.85	Titanium oxide (TiO_2)	0.76
		Phosphorus pentoxide (P_2O_5)	0.25
		Calcium oxide (CaO)	1.33
		Magnesium oxide (MgO)	1.10
Fusing point of ash, about 1,950 deg. F.		Sulphur trioxide (SO_3)	1.80
		Undetermined	0.25

When chilled into a solid state the slag had a very low coefficient of heat transmission, a fact that made it serve as a good heat insulation for the well floor, as the lower part of the slag bed solidified owing to the passing of secondary air beneath the bottom of the well. This characteristic also added to the problem of handling, as will be discussed later.

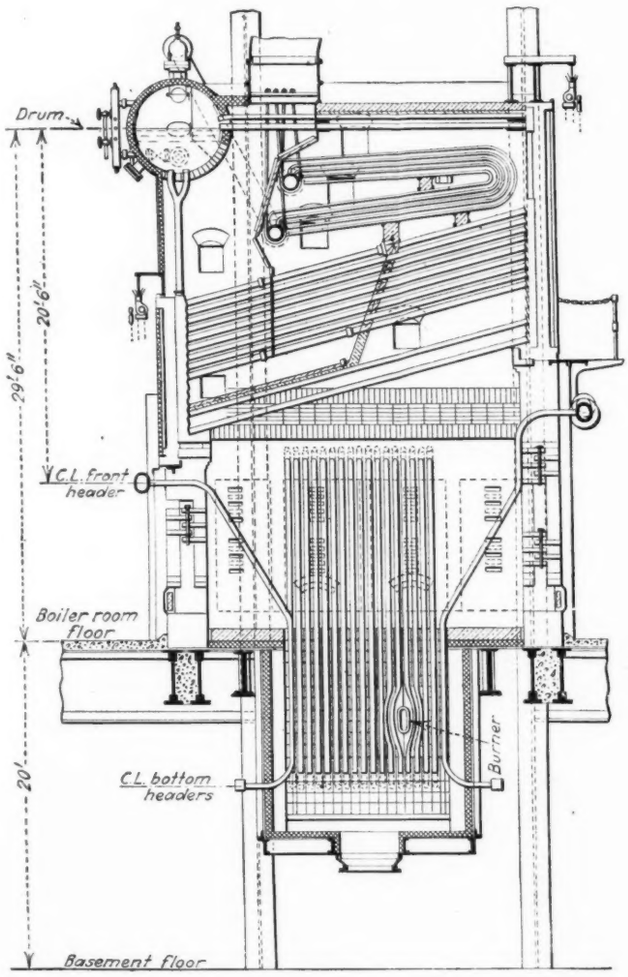

Fig. 3—Furnace of No. 13 boiler

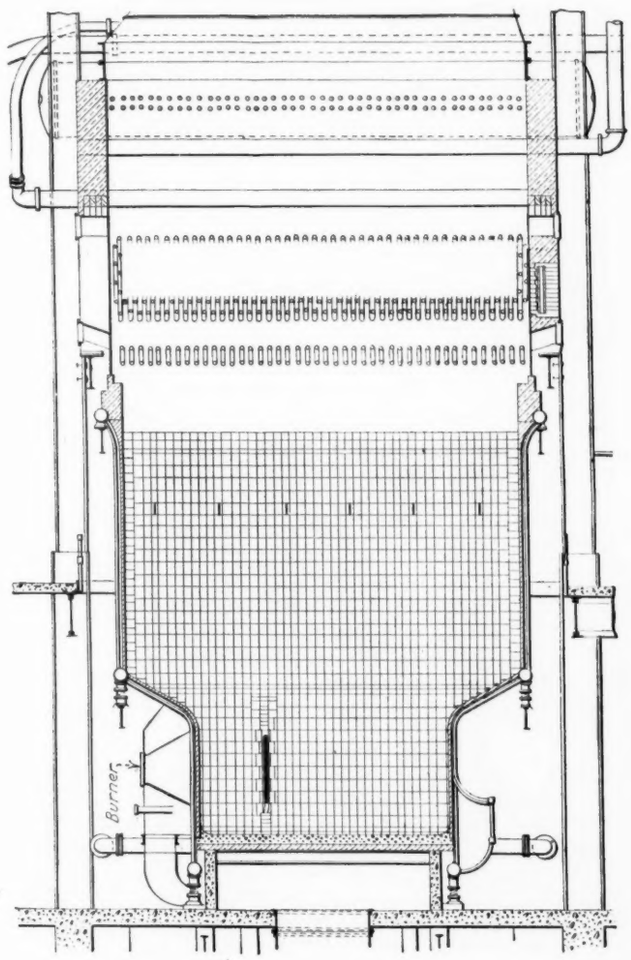

Fig. 4—Furnace of No. 15 boiler

At a high temperature and below its melting point the slag was tough and viscous, like molten glass. When cool it was a dense black solid, often with a coppery opalescence at a fracture; it was hard enough to cut glass and weighed approximately 200 lb. per cu.ft. When running from the slag spouts into the open air, the outer part of the stream congealed and the flow continued through the center, forming a tube or pipe, one of which is shown in Fig. 1.

The original method of disposal of this slag, pending

[2]Refer to paper presented at the First National Fuels Meeting of the A.S.M.E. at St. Louis, Oct. 10-13, 1927, entitled "Direct Fired Powdered Fuel Boilers with Well Type Furnaces at Charles R. Huntley Station," for further data as to the effect of these changes on the efficiency of operation.

a solution of the ash-handling problem was to allow it to run onto the floor each night before shutting the boiler down and remove it the next day with a pick and shovel gang. This method was mussy and of course impractical as the slag was hard to break, involving a high labor cost, and the concrete floor on which the hot slag was dropped chipped away due to the heat. The slag would spread around the floor, working outward

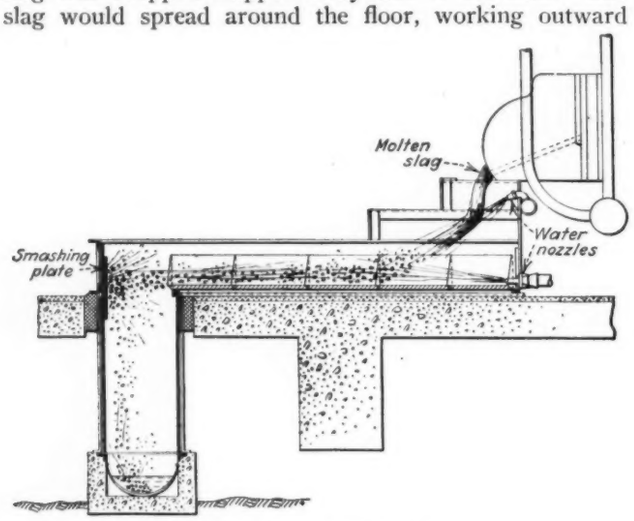

Fig. 5—Layout of sluiceway

from a point underneath the spout, resembling in its flow a bed of molten volcanic lava. A water hose turned upon it served only to chill a skin at the surface, the interior remaining in the molten state and flowing onward, bursting through the chilled skin at various places. This temporary tapping process made a weird but fascinating spectacle.

While the status of the problem was as set forth, three additional pulverized fuel burning boilers, Nos. 14, 15 and 16, of a different furnace design, were placed in service. These, shown in Fig. 4, had furnaces 15 ft. 7 in. square with walls going straight up at both ends and expanding on the sides to a width of 25 ft. 8 in., at an elevation of 7 ft. 6 in. above the furnace floor. The well floor line was 30 ft. from the lower boiler tubes. The furnace walls were of the refractory-faced Bailey block construction and had the same tube spacing as No. 13 boiler, there being, however, greater cooling surface and greater volume in the furnace. The well floor was supported on steel girders and consisted of a steel plate, over which were placed two layers of firebrick, covered with 6 to 8 in. of burnt Dolemite. These furnaces operated at a heat release of 37,000 B.t.u. per cubic foot of total furnace volume, which is equal to 236,000 B.t.u. per cubic foot below the top of the burners.

The ash in these boilers assumed the same molten form as in the previous boiler, but the slab spouts, being closer to the floor, made the solution as to ash handling more difficult.

Numerous suggestions were offered as to the best method of disposal of this slag, such as refractory-lined larry cars handling the ash in the molten state, pouring the slag into water-filled dump cars direct from the furnace, and various combinations of sluicing and elevating into cars.

The objection to handling the slag in the molten state in refractory-lined larry cars was that the spouts on the last three boilers were too low to permit an ordinary car to be placed beneath.

Although handling molten ash in such cars is everyday practice around blast furnaces, it was considered too hazardous for installation in the boiler plant and was never tried.

While the new furnaces were in the process of construction, experiments were made of dropping the slag directly from the furnace into a concrete buggy filled with water. To our great surprise no explosion occurred and there was little sputtering. The slag stream proceeded to form its own insulating tube to the bottom of the buggy and built up as if there were no water on top of it. The sheet-metal casing on the bottom of the buggy became red hot long before the surface of the water showed any signs of boiling. When the bucket was half full of slag it was rolled to one side, and some fifteen minutes later it was emptied and the interior of the slag was still red hot.

Sluicing was then tried out by placing an 8-ft. length of 12-in. channel iron, sloped at an angle of about 30 deg., under the spout of the original boiler and placing two $\frac{3}{4}$-in. water nozzles at the top so as to sweep the channel clean. The lower end discharged into an ash car.

These tests on sluicing led to observations that were of great value in arriving at the final solution. The slag stream was broken into small pieces by the mechanical force of the jets, and these pieces in turn tended to shatter into smaller pieces, owing to the rapid chilling effect of the water made possible by the exposing of greater surface areas per unit volume of slag. These facts indicated the necessity of using comparatively large volumes of water and were responsible for hydro-jet handling.

A test equipment was then installed under one boiler by the Allen-Sherman-Hoff Company. This consisted of three primary jets which threw parallel streams forming, owing to close spacing, a water table within a cast-

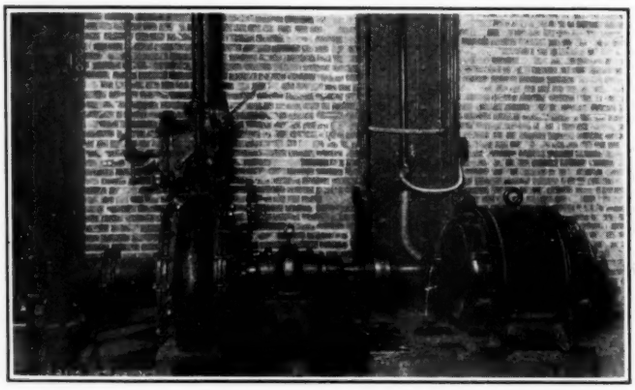

Fig. 6—Manganese steel pump for handling slag water

iron disintegrating chamber. On this the molten slag fell directly, being broken into small pieces and partly chilled at this point. Falling from here into a U-shaped cast-iron trough, the slag was carried crosswise of the building with the aid of two carrier jets for a distance of approximately ten feet, and was still further chilled in the process, owing to the additional cold water. This flow hit a cast-iron smashing plate, where it was turned at right angles into another U-shaped cast-iron trough running lengthwise of the building and discharging at a distance of approximately 50 ft. in the adjoining yard. Two additional carrier nozzles working in tandem were placed at the head end of this run.

The results from this test equipment exceeded expectations. The slag was deposited in a fine granular state at the discharge of the chute.

Steps were therefore taken to provide a permanent installation, but owing to the fact that the best point for permanent disposal was about 1,000 ft. from the boilers, it was found necessary to pump the mixture of slag and water after discharge from the hydro-jet system. The layout decided upon is shown in Fig. 5. To meet this requirement a pit was designed into which the sluices discharged. Two special manganese steel pumps, each of approximately 760 g.p.m. capacity were provided for this

Fig. 7—Discharge from slag disposal system

service and a cast-iron suction pipe run into the discharge pit. Fig. 6 shows one of these pumps. All elbows in the suction and discharge piping are of manganese steel. One pump is intended for a spare, as both are connected in parallel to the same discharge main, which is of 6-in. steel pipe running along the side of the building and out across the adjacent land to the point of disposal. The pipe is pitched to make it self-draining and is not insulated. Fig. 7 shows this discharge in service. Note that the material discharged spreads over a wide area instead of forming a pile beneath the pipe as we had expected.

In operation this system has worked out as satisfactorily as on test, although it has been found desirable to increase the pressure at the nozzles, from 100 to 140 lb. in order to handle a higher rate of slag flow. These rates of flow are uncertain, being dependent upon the length of time the boiler is in service, the furnace temperature and the prior day's firing condition and length of service.

The tapping of slag from these four boilers requires in labor the services of two men for a period of one to three hours daily. The quantity of water pumped depends more upon the time required than upon the actual weight of slag removed, as it is necessary to provide enough water during the early stages of tapping to care for the maximum flow that may be encountered, and this is a somewhat indefinite quantity on account of the stand-by peak load operation of the station. The slag may vary from a mere trickle to a 6-in. diameter stream, coming fastest just after the flow is established and decreasing in amount as time progresses. Fig. 2 shows the slag spout in action. When the flow decreases, the pressure at the jets may be throttled down as experience dictates.

As the slag is highly abrasive in its action, renewable wearing plates were placed in the sluiceways at all right-angle turns and were also placed in the concrete receiving pit to take the direct impingement of the slag bearing water.

It is remarkable that this installation, which is the first to be designed for handling molten slag from boiler furnaces by the hydro-jet system, should have proved so successful from the start. Had not the low furnace-floor levels of boilers 14, 15 and 16 made the handling of this slag in the molten stage by means of slag cars extremely difficult, this happy solution of our problem might not have been found.

WHAT DO YOU KNOW?

By L. H. Morrison

The answers are on page 767

Ques. 1—If the entire steam flow to an extraction-type turbine passes to the condenser, will the water rate of this turbine be as good as that of a turbine designed for straight condensing operation?

Ques. 2—In case of the so-called rich mixture in a gasoline engine, is there enough oxygen in the mixture to complete combustion?

Ques. 3—By making a *D* slide valve or a balanced slide valve longer, it would be possible to have the steam ports of an engine much shorter than at present. Why are the long valves not used?

Ques. 4—Are there more or fewer steam engines built than there are steam turbines built each year?

Ques. 5—Who first used the regenerative steam cycle?

Ques. 6—How long should the lap of a leather belt be?

Ques. 7—According to the steam tables one pound of steam at 200 lb. absolute pressure has a "total heat" of 1198.1 B.t.u., measured from water at 32 deg. F. Is this amount of heat actually in the steam?

Ques. 8—Is it permissible to use a standard non-rising stem valve on a 2½-in. line from a steam boiler?

Ques. 9—A change in voltage at the terminals of an induction motor, from 10 per cent above normal to 10 per cent below normal, will cause how much of a change in the starting torque?

Ques. 10—Does the sharp click heard in heating systems come from water hammer?

Baumé Gravity

THE formula now recommended by the Bureau of Standards and accepted by the petroleum trade generally for converting Baumé degrees to specific gravity is

$$Sp.\ Gr. = \frac{141.5}{131.5 + deg.\ Bé.}$$

Existing tables are based, as a rule, on the old formula, but the error is slight.

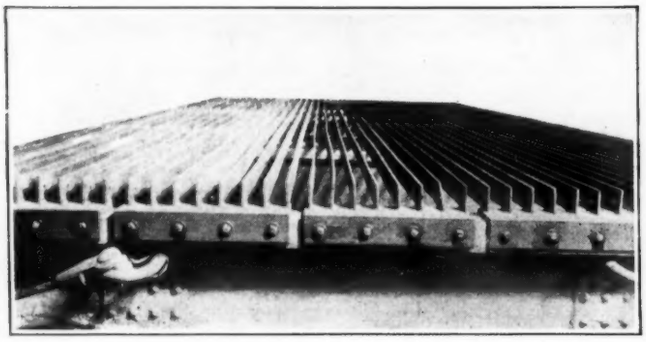

Fig. 1—Upper end of racks showing grouping of bars

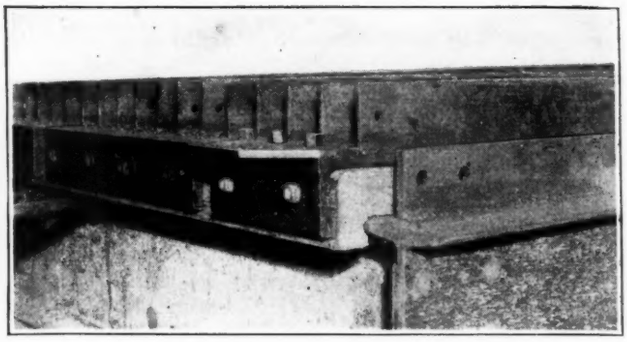

Fig. 2—Rack-bar groups insulated with wood

Electrically Heated Rack Bars *Prevent Ice Troubles*

in Hydro-Electric Plants*

By C. R. Reid

Superintendent of Generating Stations, Shawinigan Water & Power Company

Method of Application and Results Obtained with Particular Reference to an Installation at Shawinigan Falls, Quebec

FRAZIL ice is formed in turbulent open water at zero temperature. The turbulency may be caused by conditions of stream flow or it may be due to high wind. When ice begins to form on the water surface, it is in the shape of slender needle-like crystals which, if undisturbed, spread over the surface and unite to form a continuous sheet. However, if the water is turbulent, the needles are swept beneath the surface and distributed throughout the body of water to a depth depending on the turbulency. When those needles reach a set of rack bars at zero temperature they are caught on the bars like so many fibers, and a matted layer is soon formed at and near the surface of the water. This layer is more or less porous and will continue to build up until it is six inches or more in thickness. The needles freeze together and to the rack to form a mass that, while not nearly so strong as solid ice, it is practically impossible to clear off by mechanical means. At first the layer of ice forms on the bars only to the depth to which the needles have been carried by the turbulency of the water, but as the openings are stopped up near the surface, they are carried downward by the entering water. Thus the layer is extended downward until the flow is practically cut off. The head is likely to drop on the lower side of the racks owing to the water draining away through the turbines, and the resultant unbalanced pressure may be sufficient to crush the rack structure.

Overcoming Frazil-Ice Troubles

The best method of overcoming frazil-ice troubles is through proper design of the hydraulic system above the rack bars. A large body of quiet water will freeze over quickly and an ice covering of sufficient size will intercept the frazil ice. This is due to the ice needles either adhering to the under side of the ice covering or being remelted in the warmer water under the ice. If the velocity of approach is low and the racks are set at a considerable depth, and if the bed of the approach channel is smooth and grades down easily to the bottom of or below the racks, frazil-ice troubles should not occur. The most common method of dealing with frazil ice is to raise the racks and let it pass through the turbines. Rack lengths are usually made in two or more sections. It is usually sufficient to raise the top section from three to six feet. The upper rack will be covered with frazil, but after that the needles are carried down and pass through the opening, leaving the lower part of the racks free from ice. Except in the case of very low heads the frazil passes through the turbine without giving any trouble. In some low-head plants electric heating has been applied to the runner to keep it clear of ice. The worst objection to raising the racks is that it defeats the purpose for which the racks are intended; that is, to keep trash out of the turbines. Trash entering the turbines blocks the water passages, reduces the output of the unit, causes unbalance of the runner, with consequent vibration, and may do considerable damage to the runner and guide vanes. It is necessary to shut down the turbines frequently for cleaning during the time the racks are raised. As a usual thing, frazil-ice trouble lasts for only a week

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or two while the river is freezing up and occasionally in the spring after the ice has gone out.

If it is desired to operate without raising the racks, it is necessary to provide some form of heating for the rack-bars in order to prevent the adherence of the frazil ice. At Shawinigan Falls electric heating has been successfully applied for this purpose.

In the design of the installation at Shawinigan Falls, use was made of the published data on the rack-heating equipment in several Norwegian and Swedish plants. These data were obtained from a paper entitled "Ice Troubles in Norwegian Power Plants," by Mr. Ruth, published in the Transactions of the World's Power Conference, London, 1924, and from an article in the Swedish *Teknisk Tidskrift Electrotechnic*, No. 1, 1917, describing the rack-heating equipment at Trollhattan.

Electric Heating Rack-Bars

It is difficult to determine exactly the amount of energy required to keep the racks free from ice. An installation might work successfully on a number of occasions and then, perhaps because of a combination of severe ice conditions and low voltage on the heating circuit, might prove inadequate. The data available on the Norwegian and Swedish installations show an energy consumption of from 140 to 425 watts per cubic foot of water per second, and these installations were reported as working satisfactorily. For the installation at Shawinigan Falls provision was made to obtain an energy input of 225 watts per cubic foot of water per second with transformer taps providing to allow for a maximum of 425 watts if required.

The racks of the 40,000-kva. unit are arranged in five bays. Each bay is twelve feet wide, and the racks extend to a depth of 25 ft. 6 in., made up of three sections. The top section, ten feet six inches, and the middle section, ten feet in length, are heated. There are 48 bars of $3\frac{1}{2}$x$\frac{5}{16}$-in. section in each bay. These are grouped four in parallel and twelve such groups in series. Connection is made between the bays so that $2\frac{1}{2}$ bays constitute one series circuit with 30 groups of four multiple bars connected in series. This gives a circuit length of 20.5x30, or 615 ft. exclusive of connections. The two circuits obtained in this way are supplied with two-phase 30-cycle current from the secondaries of two 750-kva. transformers which are connected to a 2,200-volt circuit direct from the power house busbars.

The rack-bars are supported by being electrically welded to pieces of structural steel angles, as in Figs. 1 and 2. At the top and bottom these angles are long enough to bridge eight bars, and thus serve to connect electrically one group of four bars to the next. The intermediate angles bridge four bars only. The angles are supported on oak pieces that are attached to the rack frame and serve as insulation. The oak pieces are L-shaped in order to support the weight of the bars in compression. Connection is made between the bars in the upper section and the middle section by means of fishplates, as in Fig. 3. Connection between the transformers and the racks is made with two $\frac{5}{16}$-in. copper bars in parallel laid in ducts and insulated by hardwood cleats.

An average set of electrical readings on one transformer secondary and rack circuit is as follows:

Voltage at transformer terminals, volts	135.5
Voltage at rack terminals, volts	126.5
Current, amperes	3,680
Output at transformer terminals, kw	347
Loss in connections, kw	7
Input into one rack circuit, kw	340
Total input into racks, kw	680
Power factor measured at transformer terminals, per cent	69.7
Power factor measured at rack terminals, per cent	73.2
Energy per cubic feet per second, watts	227.0

Sufficient experience has been gained with this installation to demonstrate that just about the right amount of energy input has been provided. Severe frazil-ice conditions have been handled with entire success on several occasions. It has been found, however, that broken ice is cleared slowly by melting. If it comes onto the racks in considerable quantities, it is necessary to clear it off by hand in order to prevent the drop through the racks becoming excessive.

The energy required for a given installation may be assumed to be directly proportional to the total length of rack-bar and velocity of the water passing the bars. This relationship may be expressed by the formula,

$$P = KNLV \qquad (1)$$

in which P is the energy in kilowatts, K a constant to be determined, N the number of bars, L the length of each bar, and V the velocity of the water entering the racks.

Formula 1 may be modified to read,

$$P = K\frac{NSLV}{S} = K\frac{AV}{S} = K\frac{Q}{S} \qquad (2)$$

in which S is the spacing of the bars, A is the area of the racks and Q the quantity of water. It will be convenient to take S in inches and Q in cubic feet per second. A further variable that might enter into the formula is the width of rack-bar. The wider the bar the more subject it will be to the cooling action of the water.

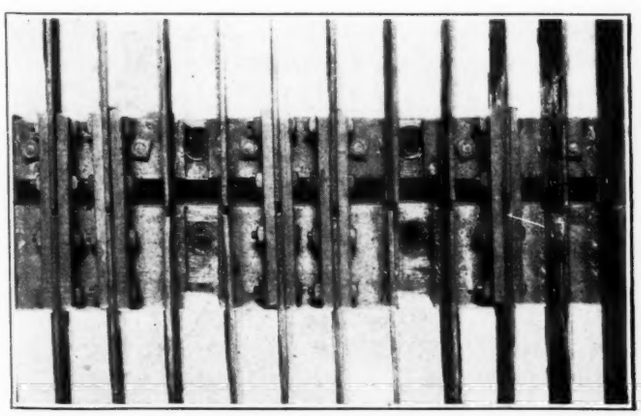


Fig. 3—Connections between upper and lower section of rack-bars

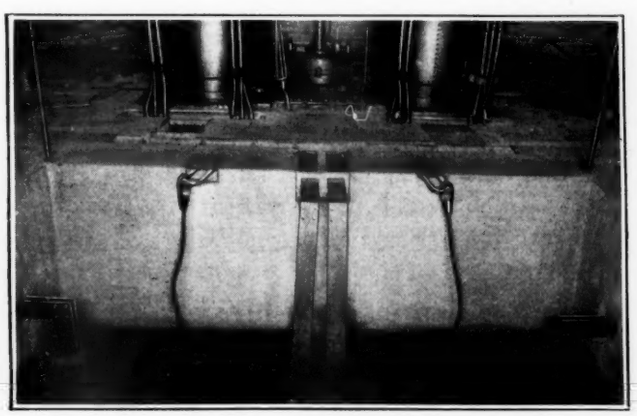


Fig. 4—Connections between the transformers and the rack-bars

However, since rack-bars for modern installations are usually between three and four inches in width, this factor may be neglected, at least for a first approximation.

Substituting in formula 2 the values P, Q and S used in the Shawinigan installation gives a value of about 0.7 for K.

The empirical formula,

$$P = 0.7 \frac{Q}{S} \qquad (3)$$

is to be considered as a first approximation in determining the energy required. On this basis low-head plants are not economically barred from the use of heated racks.

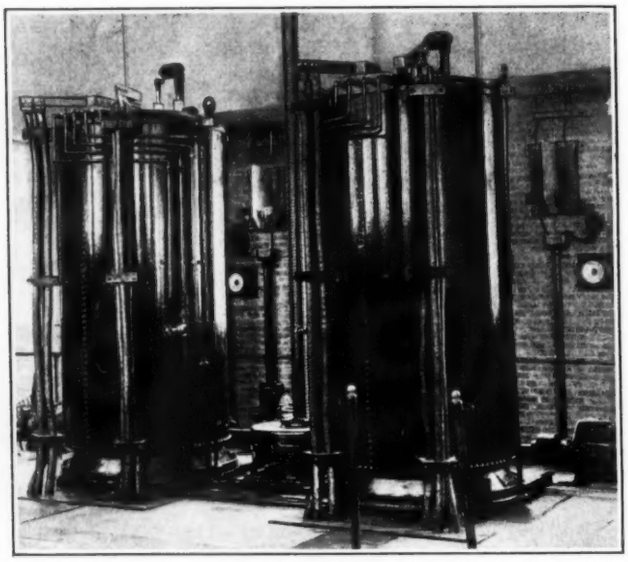


Fig. 5—Bank of two 750-kva transformers for heating the rack-bars

If the rack spacing can be increased in proportion to the increase in the quantity of water required per unit of output, the percentage of energy required for heating should remain the same.

In the foregoing calculation it has been assumed that all the water passes through the heated portion of the racks. Since the lower five feet, which is unheated, is likely to be stopped up at times with logs and trash, this assumption is valid. However, it would be satisfactory to heat the racks only as far down below the surface as the turbulency of the approaching water carries the frazil

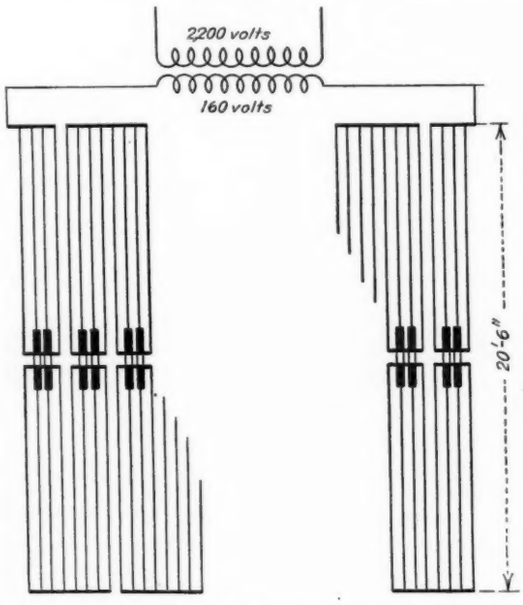


Fig. 6—Diagram of transformer and rack-bar circuits

ice, if such a point could be determined. In such a case the energy requirement could be cut down in proportion. In a more recent installation the upper halves of the racks only have been heated.

Electric heating of racks is of particular value in locations where frazil ice trouble develops quickly and where it is not of long duration. When such trouble is experienced more or less continuously, it would no doubt be more economical to install rack-bars made of tubing welded into headers and to circulate warm water through them.

From an operator's viewpoint it is reassuring, during ice troubles, to know that the units with heated racks may be relied on to carry their full load.

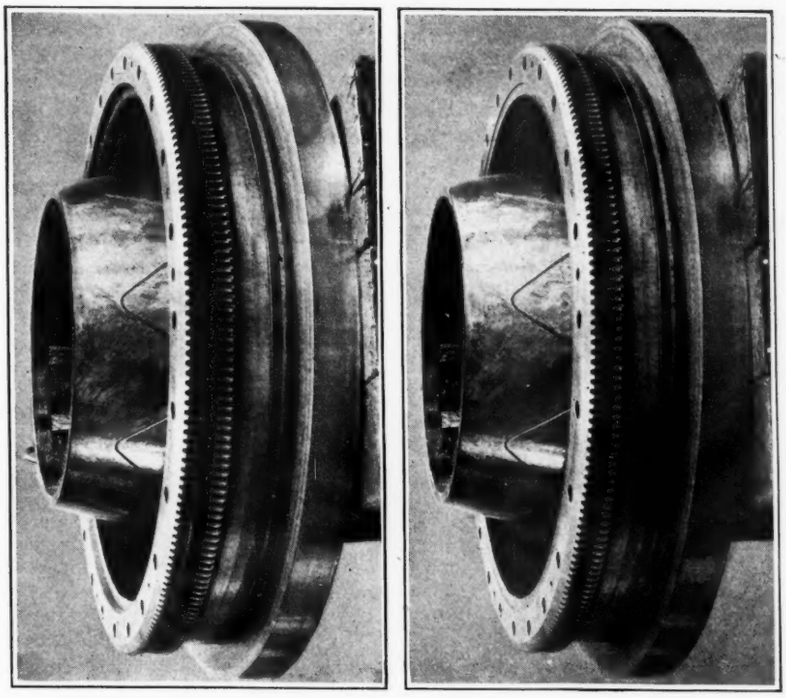
What If It Happened To You?

One day a smooth-running boiler house—the next a tangled mass of tubes, drums and steelwork, half buried in brick and mortar!

Not a happy situation to face with production calling for steam and electricity.

It happened at Harvey, Illinois, and the sequel will be told in the May 8 issue of *Power*. Emergency supplies of steam and electricity were obtained within a few days, while a new boiler house was constructed and the first boiler put on the line two months after the equipment was selected.

Knowledge is valuable, however obtained, but in matters of this sort it is cheapest to profit by the other man's experience. That is why *Power* gives special attention to stories of plant disasters and the handling of emergencies.



The new wormwheel (shown on the left) was made in halves

ELIMINATING NOISE *in High-Speed Gearing*

By I. SHORT

Marine Engineer, Westinghouse Electric & Manufacturing Company, South Philadelphia Works

IT IS the opinion of many that a silent high-speed gear is impossible to manufacture. This, however, is not the case. High-speed gears reducing from 6,000 to 1,200 r.p.m., have been operated at full load of 100 kw. and have been found to operate so quietly that, with a handhole cover removed, the only noise that could be heard was the splashing of the lubricating oil inside the housing. It was impossible to distinguish any change in the sound of the unit when full load was applied or released. Gears such as these are not commercial gears, but commercial gears are being made to approximate closely this ideal.

At one time it was thought that in order to make a gear operate silently, it was necessary to cover the gear case with hair felt or other noise-absorbing substance, in order to prevent the sound waves from being carried away from the gear. It has been demonstrated, however, that covering the gear with a noise-absorbing substance is quite ineffective. The most logical and satisfactory means is to prevent the formation of the sound waves. In order to do this, it is first necessary to determine the cause of the wave. A simple instrument for this purpose is shown in Fig. 1.

This consists of a tube inside of which is fitted a sliding piston. The piston has at the center a relatively small hole connected by a rubber tube to earpieces such as used on a stethoscope. The person using the instrument need be only near enough to hear the sound from the gear. With the earpieces fixed to shut out stray sounds, the piston is moved in the tube until the sound is heard most distinctly. Generally, the test is started with the piston pushed as far into the tube as possible and it is then gradually drawn out. When the point at which the sound is heard most distinctly is reached, the length of the air chamber is noted. The piston is then gradually withdrawn farther until the sound is again heard equally distinctly, and the length of the air chamber is again noted. If the tube be long enough, several of these points of distinct sound will be found. Upon checking the distance between points, it will be found that the points are equal distances apart and about twice as far apart as the first point is from the mouth of the tube. It will generally be found that several notes can be heard. In finding the distinct points, care must be taken to take the measurements at points of the same tone at all times.

Moving the piston until the most distinct point is reached makes the column of air inside the tube resonant with the sound being emitted from the gear. This column of air acts as a spring and is made to vibrate in synchronism with the sound waves.

From the theory of sound it is known that the

positions of the piston when the sound is heard most distinctly are nodes and that they are each one-half wave length apart and that the first node is one-quarter wave length from the mouth of the pipe. Experience has shown that the position of the first node is not exactly one-fourth wave length from the mouth, and in taking the readings at least two nodes are determined if possible, as it has been found that the distance between nodes is always exactly one-half wave length. Experience has also shown that several resonators are required for the greatest accuracy. For low tones a long resonator of large diameter is needed, while for high notes a short one of small diameter is best.

The wave length of the sound is determined by means of the resonator, and the next step is to find how many sound waves are emitted for each revolution of the gear in order that the cause may be traced. It is known that the velocity of sound at 70 deg. F. is about 800,000 in. per min. This velocity is taken in inches per minute, as the wave length is most easily measured in inches, and while the wave length is being determined, the speed of the gear in revolutions per minute is noted. The number of waves per revolution is then obtained from the formula, Waves per revolution $= 800{,}000 \div (W.L. \times R.P.M.)$

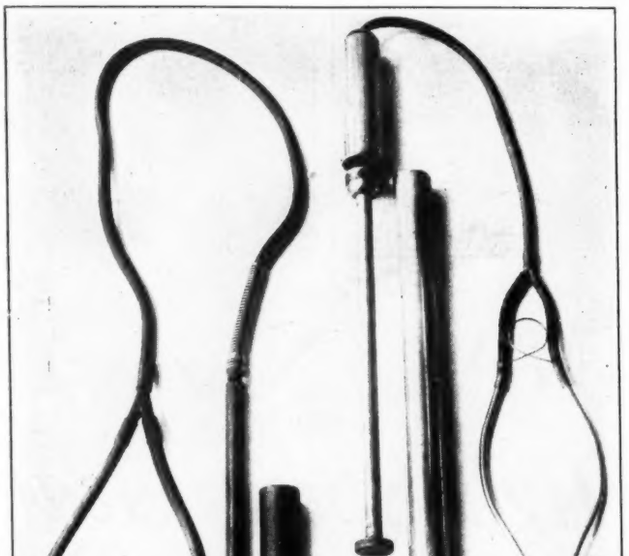


Fig. 1—The resonator employed for determining the wave length

To illustrate the method of determining the source of noise, two cases will be described. It might be well to state that practically all cases of gear noise where the gear has a steady hum can be traced to one or both of these sources. These two noises have been termed the "Hobber" noise and the "Contact" noise. They will be described in the order in which they were found, and the method of correction will be described as well.

Hobber Noise

During the War a number of gears were built for twin-screw ship drives to transmit 14,000 shaft horsepower on two pinions and with a speed reduction of 3,000 to 550 r.p.m. The gears were not operated under load in the shop owing to the high power. On the trial of the first ship the noise from the starboard gear was practically unbearable, while the port gear was relatively quiet. The first attempted remedy was to lag the gear case, but this had no appreciable effect. Then began a search for the cause of the noise.

Similar gears of other manufacture which were cut with smaller teeth and a steeper helical angle, operated comparatively quietly. A test gear wheel and pinions were cut with practically the same tooth characteristics as the comparatively quiet gears, but gave no better results.

By means of the resonator it was finally discovered that no matter at what speed the gear was operated, there were found to be 120 sound waves per revolution. On investigation it was found that the master wormwheel of the hobbing machine on which the gears were cut had 120 teeth. The gearing of a hobbing machine is shown diagrammatically in Fig. 2. Readings taken on the hobbing machine indicated that with each revolution of the single-thread worm driving the table, the latter was accelerated and retarded and did not revolve at a uniform speed. This error was reproduced in the gear being cut, and when driven by the turbine through the pinion, either the turbine or the gear wheel had to accelerate and retard 120 times during each revolution of the gear wheel. This was thought certainly to be the cause of the noise, and immediate action was taken to build a master worm and wormwheel that would not produce this error.

The new wormwheel was made in halves, as shown on page 761. This was cut on a machine known to have the objectionable error. After being cut, the two halves were pulled apart and one revolved 180 deg. with respect to the other. With the teeth in line on one side they were found to be out of line on the opposite side. This represented the error in pitch of the wormwheel. The wormwheel was mounted so as to be free to rotate and lapped with a cast-iron worm. This tended to halve the existing error. This procedure was repeated, revolving one-half with respect to the other each time at 90, 60 and various angles of rotation until no appreciable accumulated error could be found. A bronze worm was then made to fit the lapped wormwheel.

The gear wheel, when recut, showed improvement but was not considered entirely satisfactory.

It was then realized that even though there was no apparent error in the pitch of the master worm, a straight worm would not drive the table at a uniform speed. A "Hindly" or hourglass-shaped worm was no better.

As the error occurred 120 times per revolution of the gear, this error occurred 360 divided by 120, or every three degrees, or the "angle of error" was three degrees.

Calculation showed that the "angle of contact" of the gear was about $2\frac{1}{2}$ deg., or well within the "angle of error." The tooth action could be represented by a boat riding waves on the water. With the boat length less than the pitch of the waves, the boat would bob up and down continually. If the boat length was doubled or the pitch of the waves halved, the boat would ride the waves evenly and not bob up and down.

A new worm and wheel was made for the hobbing machine having 240 teeth instead of 120, which gave an

"angle of error" of 1½ deg. The "angle of contact" remained 2½ deg. With this hobbing machine the "angle of contact" was greater than the "angle of error." The wheel was constructed in halves as already described, to insure the highest possible accuracy.

It was found that gears and pinions cut with the rebuilt 240-tooth hobbing machine operated with practically no noise. Gears previously considered quiet were now classed as noisy when compared to those cut on this machine.

All the hobbing machines were rebuilt, and at the present time care is taken in selecting a machine that will give an "angle of contact" that will overlap considerably the "angle of error." To prevent undue wear of the hobbing machine, as few teeth as possible are desired in the master wormwheel. Hobbing machines are available having 90, 120, 180, 240 and 480 teeth in the master wormwheel.

On new gears it is often found that there is contact only along a narrow strip of the tooth face. If the teeth on the pinion and wheel were perfect, contact would show from the tip to very near the base of the tooth. The tooth profile, however, is never perfect and full tooth contact on a new gear is seldom obtained. With a narrow strip contacting, the "angle of contact" is of course very small and the hobbing machine noise will be heard. A gear that is noisy on the test floor, is investigated with the resonator to determine whether the noise is due to insufficient contact or some other cause. Generally, it is found that the hobbing machine noise is heard, and this is eliminated by scrapping the high spots of the teeth, thus allowing the contact to spread over more of the tooth surface. When the tooth contact is broad enough the hobbing noise will disappear. Hand scraping has been found to be necessary in order that the gears will start up quietly in the field. With proper lubrication it is found that practically no wear takes place on the teeth and the gear would have to operate for a considerable length of time before the contact would be broad enough to eliminate the hobber noise.

TO SUM UP

. . . High-speed gears need not be noisy if manufactured with proper care.

. . . Noise is not to be cured by lagging the gear case with hair felt or other sound absorber.

. . . An adjustable resonating "stethoscope" tells the number of clicks per revolution of the gear.

. . . "Hobber noise" can be avoided by perfecting the hobbing machine.

. . . "Contact noise" is reduced by designing the gear with proper relation of pitch and face width.

. . . Gear noise due to pump pulsations may be cured by proper couplings.

"Contact" Noise

For a long time a note was always heard having one wave length for each tooth of the gear wheel. This was thought to be due to imperfect contact and was sometimes reduced in volume by scraping the teeth. The noise became very troublesome on some 100-kw. units on which the reduction was from 7,200 to 900 r.p.m. On this type of gear the pinion diameter was 2.309 in. with a face width of 2¾ in. for each helix. These were fixed bearing gears. One particular gear that was operated on Sundays and holidays in a manufacturing plant, was returned to the manufacturer to have the noise reduced.

The gear was placed on the test floor and operated to determine how much and the kind of noise it made. A number of distinct notes could be distinguished with the resonator. The most prominent note was that which had one wave length per tooth of the gear. Scraping and recutting of the teeth was tried, which bettered the operation but did not entirely remove the most prominent

While the gear was being tested and different pinions and gears being tried to obtain a combination that would operate quietly, a suggestion was received for a method of cutting helical or spur gears so as always to have an even number of teeth in contact. Investigation showed that the gear on test had a face width on each helix of 4.8 axial pitch and the line of contact in the plane of rotation was 1.4 in. pitches long. This meant that for four-fifths of the time there were five contacts across the face and for one-fifth of the time only four teeth in contact. On the line of contact for two-fifths of the time there were two teeth and for three-fifths of the time there was one tooth in contact.

As an experiment the face width was reduced from 4.8 in. pitches to 4 pitches. The noise from the gear was still very loud, but there was an appreciable difference in the volume. With the face width further reduced to 3.5 in. pitches, the volume became greater and was reduced again by turning the face width to three pitches. These changes did not greatly affect the noise. But the volume was appreciably less with the face width an integral number of pitches wide than when a fractional number of pitches was employed.

The experiment was carried further by turning enough off the tips of the pinion teeth to reduce the length of the line of contact to exactly one pitch. This further reduced the volume of noise, but still it was too great. These experiments, however, demonstrated that there probably was virtue in the suggestion. A new pinion and wheel were made to give exactly an even number of pitches for each face width and to have exactly two teeth in contact at all times on the line of contact.

Below are the characteristics of the original pinion and gear and of the special pinion and gear that were made:

	Original	Special
No. of teeth per pinion	21	23
No. of teeth per gear	169	185
Diametrical pitch	11	11
P.C.D. pinion	2.309	2.216
P.C.D. gear	17.740	17.827
Outside diameter pinion	2.491	2.408
Outside diameter gear	17.922	18.018
Helical angle	30°	19° 22′
Face width helix	2 3/4 in.	2 10/32 in.
Face width (pitches)	4.8	3
Line of contact pitches	1.4	2.0

It was necessary to maintain the same center distance between pinion and gear shaft, as this was a rigid bearing gear. It was also necessary to maintain approxi-

mately the same reduction ratio. The only allowable variables were the diametrical pitch, number of teeth and the helical angle.

With a hob having a pressure angle of 14½ deg. and cutting a 30-deg. helical angle, the pressure angle in the plane of rotation is about 16 deg. 38 min. It should be mentioned that increasing the length of the line of contact necessitates either an increase in the height of the teeth or a decrease in the pressure angle in the plane of rotation. Calculations show that with standard teeth

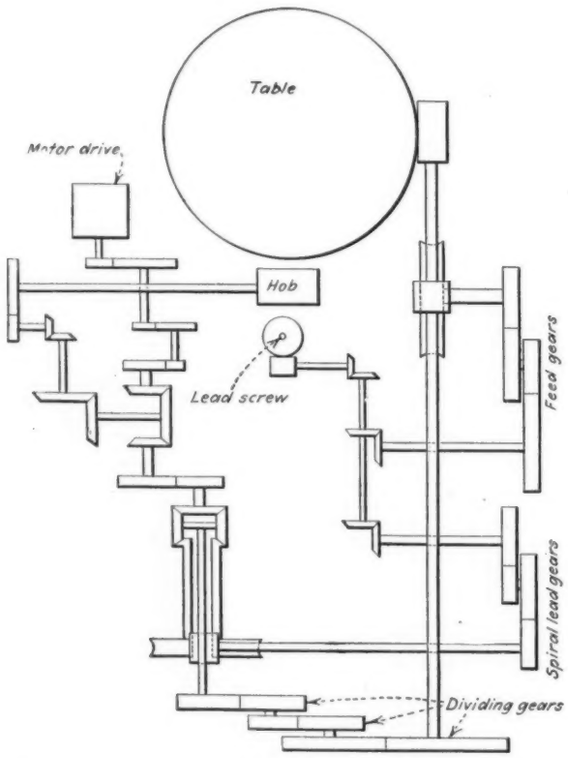


Fig. 2—Gearing of hobbing machine represented diagrammatically

the helix angle required to give a line of contact two pitches long, must be approximately 20 deg. for the ratios ordinarily used. The exact helical angle to be used depends on the number of teeth in the pinion and gear.

Contact of Two Teeth Necessary

On a new gear it is practically impossible to obtain tooth contact for the full depth of the teeth. It is also known that after a gear has been in service for some time, the metal in the teeth actually flows even though no wear takes place. Metal flows off the tips of the pinion teeth, forming what is commonly called "wire edge" and the same time there takes place a flow of metal toward the pitch line of the gear teeth.

For this reason the number of teeth in contact on the line of contact was made slightly greater than two. On a new gear the contact of two teeth is then more easily obtained, and it is thought that after the gear has been in operation for some time it will still closely approach two teeth in contact at all times.

The special set of gears produced a surprisingly quiet running unit. The same design gear and pinion has since been tried in other geared units with equally good results. It is now believed that many gears that operate quietly in the shop and became noisy in the field had only enough contact while new to approach the "even contact" design, but as the contact broadens out the wave-per-tooth noise became prominent.

The noise is no doubt due to the tooth deflection during the different phases of contact continually changing a microscopic amount and generating a sound wave. With the line contact exactly two pitches long and the face width an integral number of pitches, the tooth deflection is constant and a sound wave cannot be generated. On all small gears having a comparatively narrow face width, this construction should be used. With a narrow face-width there are only a few teeth in contact and the change of loading or the variation in the deflection of the tooth is greater than on a gear having a wide face width, which would have a large number of teeth in contact across the face. With the narrow face-width gear the change in loading might be equivalent to alternating between four and five teeth carrying the load, while with the wide-face gears this might be equivalent to alternating from 16 to 17 teeth carrying the load.

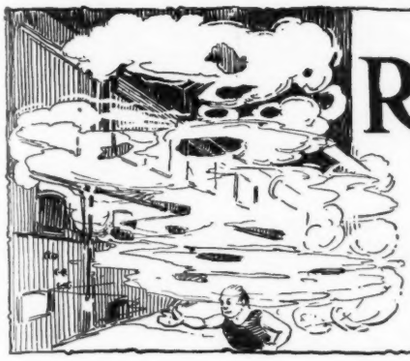
On commercial gears the "even contact" design is not considered necessary on gears having a comparatively wide face width. There are applications, however, such as in hotels, office buildings and department stores, where as near a silent machine as possible is required. For these special cases the "even contact" design should be used for the large gears as well as for those having a narrow face width.

With all gears, in order to insure silent operation, it is necessary to have correct alignment between pinion and gear. If the pinion and gear are not in correct alignment, concentrated load results at the ends of the helixes, producing the effect of cutting down the face width and destroying the "even contact" feature. With a narrow face width sufficiently accurate alignment can usually be obtained with the pinion supported in rigid bearings. Wide face-width pinions should be supported in a floating frame which automatically insures correct alignment.

Other Noises

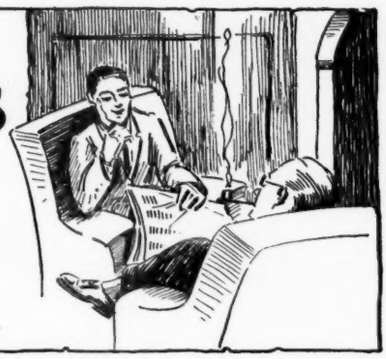
The foregoing is responsible for most noisy gears. There are, however, noisy gears that cannot be traced to these causes. One application for gears which occasionally gives trouble, is that of circulating pump drives. There is no doubt that the pump is the cause of the noise in the unit, but as the noise is generally heard at the gear, the gear manufacturer is asked to make the unit operate properly. The centrifugal pump does not operate with a steady load. Eddies and cavitation take place in the pump, and the result is a high frequency pulsating load. These pulsations are of such high frequency that they are not indicated on the inlet pressure gage to the turbine drive. Unless there is a torsionally resilient coupling between the pump and gear, the teeth are likely to leave contact and result in a chattering gear; or, even if the teeth do not leave contact, there is sufficient change in tooth deflection to cause an objectionable noise.

The remedy is to place the most torsionally resilient coupling available between the pump and gear. Occasionally, it may be necessary to assemble the pinion and gear with the least possible running clearance to minimize the chattering. On drives in which there are two bearings on the gear and one on the pump, making a three bearing set, it is difficult to fit a torsionally resilient coupling between the gear and pump. A quill shaft can, however, be fitted in the gear shaft with a steady bearing at the end inside the gear shaft.



Reminiscences of an Engineer

By Hubert E. Collins



The Greatest of Them All

JACK MURPHY had taken time off from his duties as Chief of the Union Railway's West Farms power house to call on his engineer friends in the Mill Street power house in Astoria, on Long Island. He brought shop news with him.

Said he: "I hear they are getting ready to build the biggest power house in the United States right across the river at Ninety-sixth Street and East River. I just stopped there on my way over, and they have some foundations in and a temporary station with boilers, engines and the biggest air compressors I ever saw installed in a wooden shed."

His friends surrounded Jack as he imparted this news, and as they talked together the group moved out on the power-house dock, where all could look across the turbulent waters of Hell Gate and view the locality they were talking of. It was at some distance, but all eyes there were good. From the point of vantage of the dock the men could make out the shape of a new shed, which, Jack said, contained engines larger than any in the Mill Street station. As Jack had charge of engines not over 800 hp., he was somewhat jealous of the larger one in Mill Street, and the first thought after his information sank in was that of making his friends jealous, especially Harry Collier, who erected what he thought was the largest engine in the Metropolitan district two years before.

Jack grinned and continued, "Yes sir! They have two 1,500-hp. engines there right now, furnishing temporary current for lights and power for the largest air compressors I ever saw. On top of that the real engines to go in there for the station are going to be able to drive generators of 3,500-kw. capacity."

As the information meant engines of near 5,000 hp., which had never been heard of before, Jack's friends were stunned into silence. But the informant shook his head in such emphatic manner that all others there felt there must be some truth in the news. All had engaged with Jack in debate on meeting nights more than once and there learned he generally verified his facts before retailing them. It must be so, even if hard to believe.

From that day forward, the engineers of this group of friends watched eagerly for the growth of the new power station. Harry Collier was the most interested and often crossed the Ninety-second Street Astoria ferry on the squat, red ferryboat.

Swiftly the work progressed during spring and summer, until the great, brick stack reared itself to its full height of 375 ft. On the last day of erection of this monument, while the hoisting gear still stood with the platform at the top, Harry was allowed to get in the bucket and go up through an inside diameter of 22 ft., all the way to the top. Arriving there in a stiff breeze, he felt the great stack vibrate from wind pressure. After becoming used to the unsteady motion, a look was taken from that vantage point. Up and down the river familiar sights were clear, even the old Brooklyn Bridge, miles away, and the only span about the great city over any of its waters. The Jersey shore could be seen over beyond Manhattan, the World Building on Park Row; no skyscrapers blocked the view. Over across the East River, almost close enough to touch, appeared the familiar Mill Street power house, now being dwarfed into insignificance by the greatest of them all.

Finally came the day when John Lambden arrived from the Cable Station on Houston Street and assumed charge of the great new power house. John honored visiting engineers with introductions to his first assistant, Royal D. Tomlinson, and they did the honors right. The visitors were taken to view the massive engines direct-connected to equally powerful generators, thence into the great boiler rooms, where rows of gigantic boilers were topped on a floor above by other rows.

The new-fangled stoker was being given a trial. The boilers were equipped with them on one side; on the opposite side were the sure, well-tried, good old grates for hand firing if the new contraptions proved unequal to the task, as many then thought they would be. But the stokers proved their worth and made possible the great advance in combustion that has since been universal.

The equipment of the station finally comprised eleven, cross-compound, condensing, Allis-Chalmers engines, direct-connected to Allis-Chalmers generators of 3,500 kw. each. The boiler rooms were filled with 72 Babcock & Wilcox water-tube boilers; 58 of these had 2,500 sq.ft. of heating surface each, and 14 others had 3,500 each.

The aggregate horsepower assemblage was what made this station great in 1899. The engines and generators were at that time the greatest of them all in power-house work. To be placed in charge was tantamount to being declared in the same class as a master engineer. This is the way others looked upon it and the way they classed John Lambden. The same company now has generators rated nominally at 75,000 kw., and in one unit they have

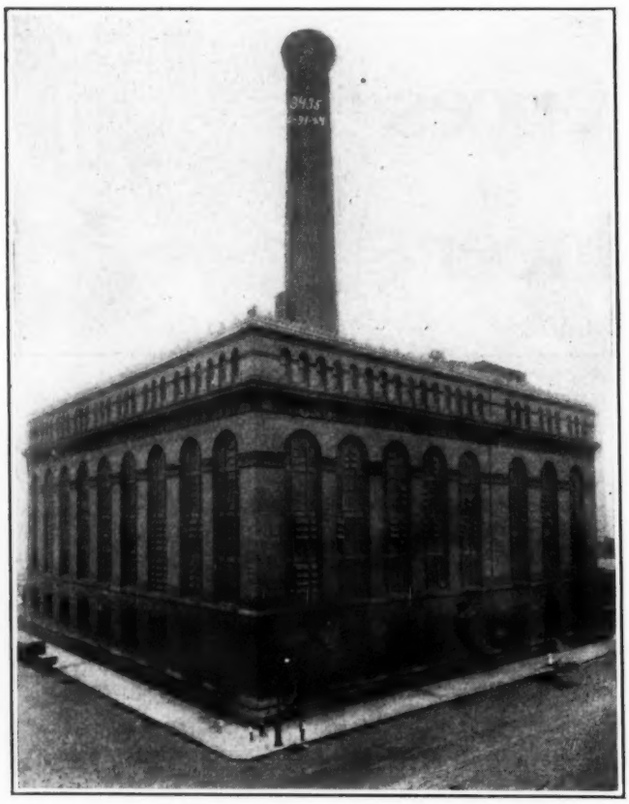


Fig. 1—The Ninety-sixth Street station of the Metropolitan Street Railway Company

almost three times the entire horsepower of the early plant. What will another 28 years bring forth in prime-mover units?

This station was a great monument to engineering skill and progress on the date of its inception. The massive walls of the building, the towering grandeur of the immense stack, all stood head and shoulders above anything of its kind. They were noticeable to the layman as well as the engineer. Engine, generator and condenser designers had reached, so they thought, the peak of accomplishment. For all that, the general public can never differentiate between a company directorate they distrust and the faithful, efficient power-house crew that gives almost unbroken service; all seem dirtied with the same stick.

Under the dynamic leadership of the chief engineer this crew acquitted themselves with honor at all times. The adjective applied to the leadership always held good wherever this man ruled. His detractors said he was too handy with his fists. The men under him said, "He sure kin scrap and lick any man who does not obey orders." The same men also add, "He always gave us a fair deal." There always was a quiet forcefulness about the man, a proved ability to handle the job and men, which won the loyalty of all who worked for him, the esteem of his contemporaries. It was just that two-fisted reputation which won the position in charge for many men in that day. Given equal knowledge of the business, the one who could take care of himself in an argument with fists, to drive home the point in a thick skull, was the one who took the place.

Yes, Lambden had to use his fists at times while in charge here, and did. Under his leadership the plant carried a rapidly increasing load without a pause.

The station had settled into regular running, furnishing power for a great portion of the New York City Railway system, and carried the greatest loads without a drop in voltage. A slackening of speed with the maximum of car-starting loads was not known at any time; the yellow press had no opportunity to raise a howl for months, ere the first break in perfect functioning came.

The engine room was resounding to the regular, rhythmic beats of dashpots on all sides; the purr of perfectly operating generators, added to the various other sounds, led the watch engineers to walk contentedly on their rounds, while the switchboard men in the gallery lolled on near-by rails as they cast an eye about. All was as it should be; Jove was in his heaven.

The boiler room was even quieter in its contentment. Clicking of stoker ratchets gave forth sounds comparatively quiet and regular like the beat of time for music, low whirring of draft fans soothed the trained ears, steam hummed a low refrain as it passed through the mains. As though to supplement the harmony on the boiler decks, feed pumps beat a low chug in regular time down in the pump pit. With these sounds came an occasional click of the cast-iron covers to peepholes, as each was opened to inspect the fire beds. Such operations allowed rays of light to leap forth with dazzling brightness into the aisles. The flashes would reveal the features of men as they peered and prodded into the incandescent beds of fire. All was serene; Old King Coal was piling up a record.

A careless erecting man had left a valve bolted loosely by one flange on the end of a line taken off the steam main leading to all the boiler feed pumps. There was no other valve between this one and the main.

The scene changed in the flash of an eye. Hissing,

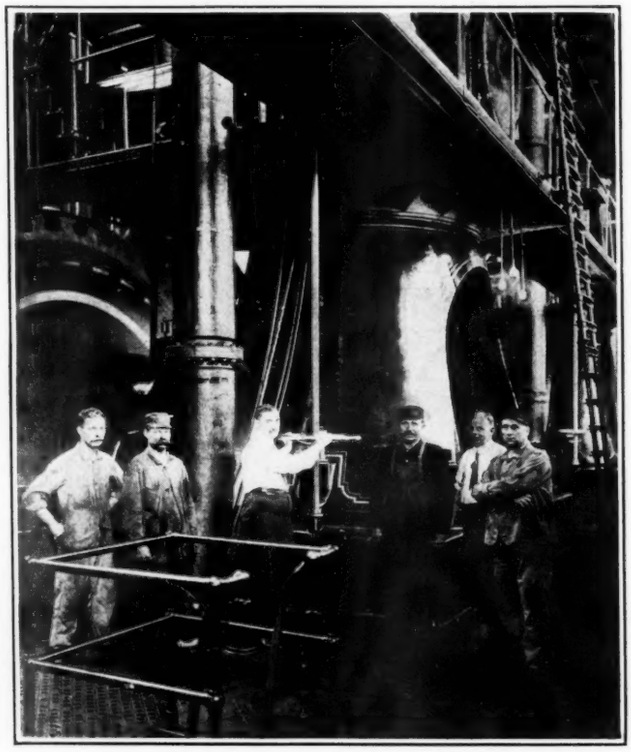


Fig. 2—Chief Engineer Sam Tupp ends the last run of the Ninety-sixth Street plant. Supervising engineer Willis Lawrence is the second man from the right

scalding steam roared into the boiler room from the pump pit.

A break had come so suddenly that no one there knew just where it was located; the steam blinded those who strove to find its source of release. The pandemonium of sound allowed no voice to be heard. Groping about in the enveloping, hot mists, engineers and head firemen tried for a long time to locate the seat of trouble. None other than those who have had the experience can visualize the terrifying conditions. The steam rapidly filled every nook and corner of the boiler rooms until the place was filled with the hot, dripping vapor, and clouds escaped from every skylight, open door and crevice. It shot into the engine room and began to saturate the delicate electrical machinery there.

In the emergency there was no recourse but to let the leak continue until the station came to a standstill. After all the steam had been exhausted, then only could the trouble be found. The valve referred to before, had blown from its fastenings and had carried some of the pipe with it. It was many hours before machinery was dried out for operation again. Not a man there failed his duty; all had stood by their stations, but of course, headlines in the papers proclaimed "Mammoth Power House Shut Down."

ANSWERS to "What Do You Know"

The questions are on page 757

Ans. 1—No. Due to the difference in design of the lower stages, the extraction turbine, when operated entirely condensing, will have a water rate from 5 to 10 per cent greater than that of the straight condensing machine.

Ans. 2—No. A rich mixture actually has a deficiency of air and combustion must necessarily be incomplete. This is why there is considerable carbon monoxide in the exhaust gases of automobiles.

Ans. 3—A long *D* valve would present too much unbalanced surface, causing the friction to be too great. This does not apply to the balanced valve, but with this design long heavy valves set up objectionable inertia forces.

Ans. 4—There are many times as many engines as there are turbines, but the total horsepower of the turbines exceeds that of the reciprocating engines.

Ans. 5—The late Bruno Nordberg designed and built a compound steam engine which was bled in stages to heat the feed water; this was the first time this cycle was put into use.

Ans. 6—If the lap is four inches, its strength, when well glued, is greater than the strength of the solid leather. A greater lap than this unnecessarily increases the belt cost.

Ans. 7—No. Part of the heat added to the fluid has been used doing external work in increasing its volume against exterior forces.

Ans. 8—The A.S.M.E. Boiler Code specifies that when over 2-in. diameter the valve must be of the outside screw-and-yoke rising-spindle type.

Ans. 9—The change in torque is 50. The torque of an induction motor varies as the square of the voltage. A 10 per cent increase in voltage above normal will, therefore, cause the motor to develop a torque 121 per cent of normal. For the same reason a 10 per cent decrease in voltage below normal will reduce the torque to 81 per cent of normal. From this it is seen that the torque at 110 per cent voltage is 50 per cent higher than at 80 per cent voltage.

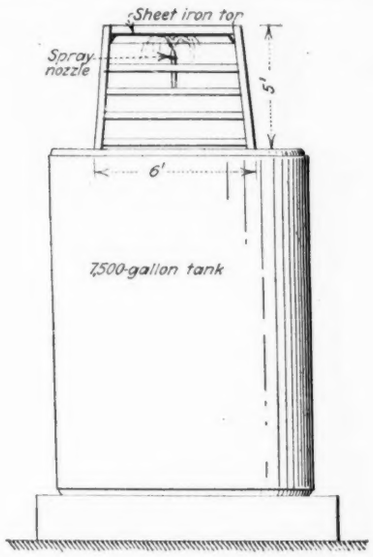
Ans. 10—No. Experiments at the West Virginia University revealed that if bubbles of water vapor are trapped in a liquid column, under certain conditions of the motion of the water the bubbles of water vapor, or steam, suddenly collapse with a sharp click. This is what occurs in a heating system when sharp clicks are heard; this sound is sharper than that due to water hammer.

A Cooling Tower for Small Diesels

By Orville Adams

MANY small Diesel installations require cooling systems, exhaust silencers, water softeners and other auxiliaries running into quite a figure, and any safe and practical method of reducing this cost is usually desirable.

Often facilities found in connection with the existing plants are utilized. The illustration shows how a water



The cooling tower and tank

tank used with an old steam plant was applied in this connection. This tank had a capacity of about 7,500 gal. and was mounted on a concrete base about ten feet from the engine room. When full, the water level was eight feet higher than the top of the engine cylinder, affording the element of safety in the event of pump failure.

Without further cooling, however, the water would in the course of a day become rather warm, and a 1¼-in. Bings spray nozzle was used, through which the water was discharged upward against a sheet-metal dome mounted on the small cooling tower. The purpose of the dome is to prevent any water windage loss. The cooling tower is 6x6x5 ft., made of 2x4-in. and 1-in. boards. The tower is hardly necessary, as the nozzle affords adequate cooling for the 60-hp. Diesel.

The makeup water consists of the rainfall on the plant roof. Additional makeup water is, however, supplied from the city mains from a connection at the top of the tank, where a ball float and valve keeps the water at a constant level. This is added protection to the engine and is entirely reliable and automatic, while at the same time full advantage of the soft rain water is realized.

Electrical Applications

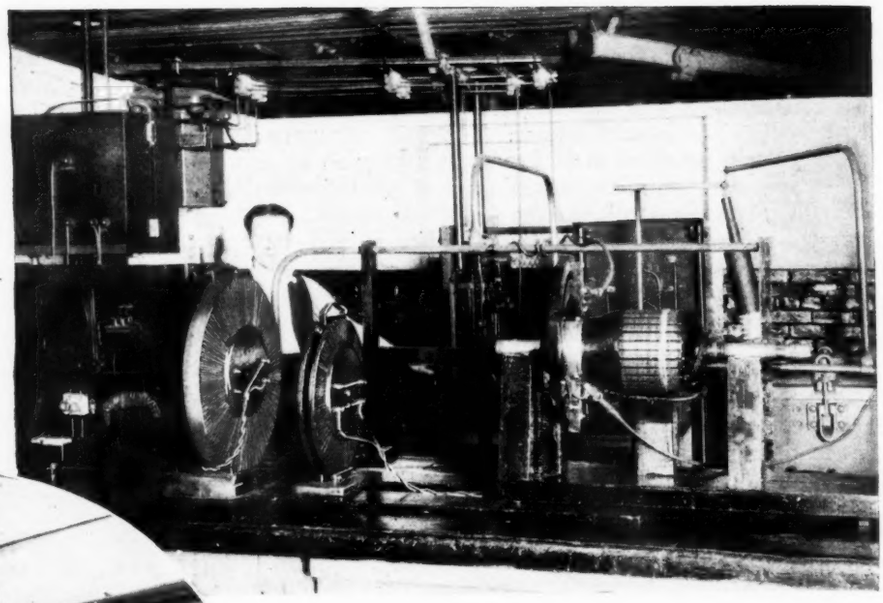


Fig. 1—(Right) After test set is adjusted to the direct-current armature, the latter is revolved slowly and if a fault exists in a coil it is easily detected on a meter

Some Applications of Radio Testing To Electrical Equipment

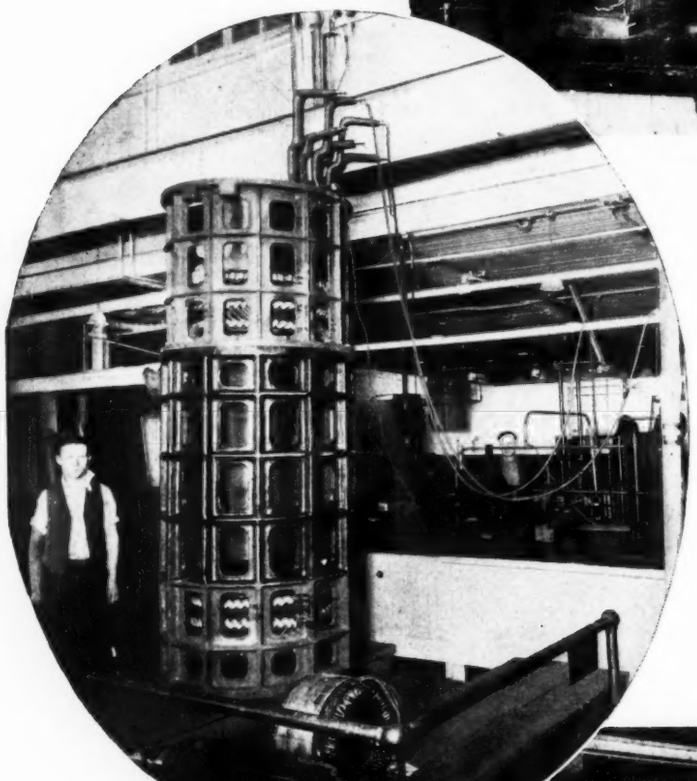


Fig. 2—(Above) Induction regulator being tested with a high-frequency current

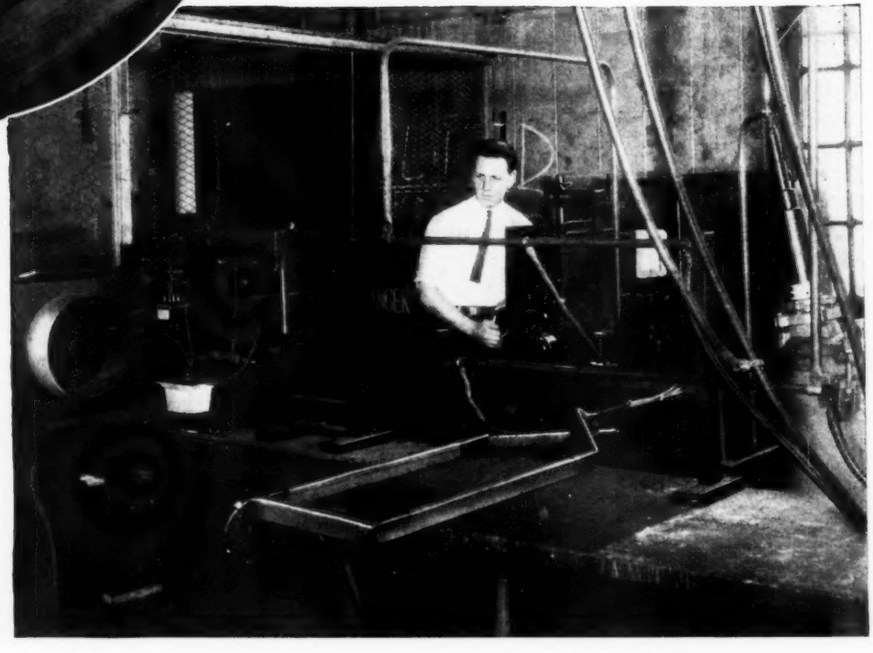


Fig. 3—(Right) High voltage being applied to a low-resistance armature coil to determine the quality of insulation between turns

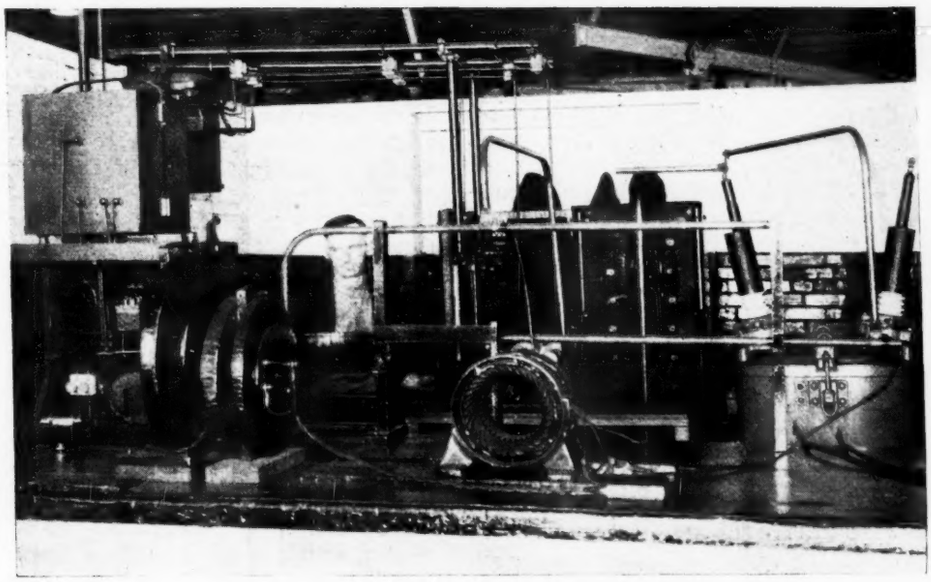


Fig. 4—Insulation test being made on induction-motor stator windings.

RADIO WAVES *Search Out Insulation Faults in Machine Windings*

By J. L. Rylander
Motor Engineer,
Westinghouse Electric & Mfg. Co.

ON JUNE 17, 1927, the world was astonished by the news that the late Judge Elbert Gary, in New York City, started the machinery of the great Homestead steel mill by merely passing his hand over a small, crystal ball placed on his desk. Incredible, almost, but not more so than talking halfway around the world or sitting in a parlor at San Francisco and listening to a New York concert. The radio wave is such a quick and reliable little messenger that it has become the busiest messenger in the world. It has snapped to the attention of many generals and has gone on a variety of missions, but one of the most unusual services it has been called upon to perform is that of detecting insulation faults in the coils of motors, generators, induction regulators and many other electrical machines. This method has proved such an efficient and vigilant detective that, since enlisting its services for commercial testing of coils, insulation failures have been almost eliminated.

To be sure that the insulation of a finished electrical machine will meet the demands of service, two insulation tests are necessary—first, a test proving that a reasonable overvoltage will not cause a short circuit between any part of the windings and the frame of the machine, and second, a test proving that a reasonable overload will not cause a short circuit between turns of the coil winding.

The first of these tests is relatively simple because impressing a high test voltage between the winding and the frame does not cause any current to flow unless the insulation fails. The second test is more difficult, since impressing a high voltage of ordinary frequency across the terminals of a coil will cause a heavy current to flow. The current flowing under these conditions may be sufficient to burn the copper and damage the insulation. A high voltage, however, may be used provided a high-frequency current is used.

With a 60-cycle current of ten amperes flowing through the coil under test, the voltage drop across it may be four volts. If the frequency is increased to 60,000 cycles, 4,000 volts would be required to produce the same current. Hence, by increasing the frequency, practically any voltage may be applied across the terminals of the coil without causing an excessive current in the winding.

Of the many ways for obtaining high-frequency current, the one shown diagrammatically in Fig. 5 has been adopted for coil testing. This spark system of obtaining high-frequency current, familiar in radio circles, operates as follows:

Power is supplied to the apparatus shown in Fig. 5 by a standard transformer. By adjusting the length of the rotary spark gap, the point on the voltage curve at which a spark will occur is determined. When this spark occurs, the condenser discharges through the coil under tests resulting in a frequency of oscillation depending on the capacity of the condenser and the characteristics of the coil being tested.

Any fault that may be present in the insulation of the coil under test may be detected by the special radio receiving set, Fig. 6, having a sensitive milliammeter in

the circuit. By adjusting the variable condenser, Fig. 6, the receiving set is tuned to the wave sent out by the transmitter shown in Fig. 5. The milliammeter, Fig. 6, will then indicate the maximum reading. If, now, with this setting a faulty coil is put into the circuit of the transmitter, the wave length will be altered, the receiving set will be out of tune and the milliammeter reading will drop.

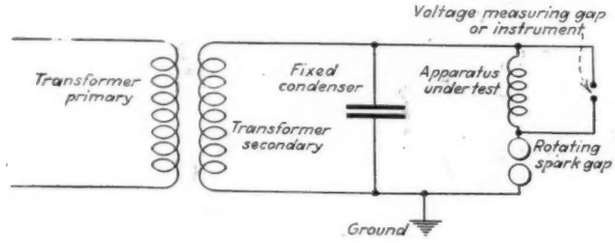


Fig. 5—Diagram of setup for testing coils with high-frequency current

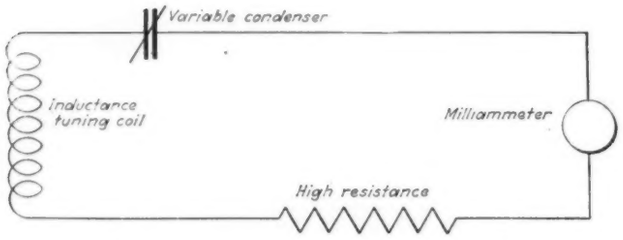


Fig. 6—Diagram of simple receiving set used in detecting faults located by the equipment Fig. 5

What does this test mean in terms of field failures? The ratio of machine failures in the field per year since the high-frequency method of testing was adopted by the Westinghouse company to the number of field failures per year before this method was in use, is approximately one to twenty. High-frequency testing shows up poor workmanship, checks the insulation design and the processes of manufacture. It insures that proper and adequate insulating materials are in their proper places and not missing or damaged and that no harmful foreign materials are present. One of its chief merits is that it invariably shows the cause of the failures, as the arc is of only such intensity as to burn out the weak insulation without burning the adjacent insulation or the copper.

Features of the Testing Equipment

The voltages used in the windings conform to the A.I.E.E. specifications of 1,000 volts plus twice line voltage. The voltage is obtained through a transformer having the secondary tapped for 7,500, 15,000 and 30,000 volts. The various intermediate values required are obtained by adjusting the distance of the voltage measuring gap. The fixed condenser has a capacity of 0.05 microfarod and is designed to withstand 30,000 volts.

The variable condenser has a capacity of 0.005 microfarod and will stand 1,000 volts. The inductance tuning coil should be placed about a foot from the iron stator core.

In the milliammeter circuit the resistance is for protection to the instrument and consists of two units, one of 1,000 ohms and one of 250 ohms. These are both variable and are connected in series. The spark gap is adjusted by turning a handwheel fastened to a threaded rod supporting one side of the gap.

The rotating speed used for the gap is 1,700 r.p.m. The speed is not at all critical, being used only to prevent burning the rotating disks.

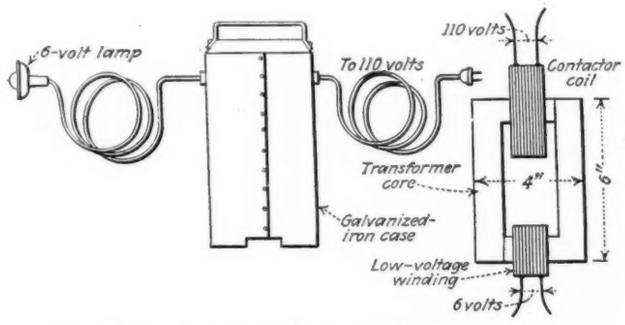
Up to 5,000 volts one-centimeter spheres are used in the voltage measuring gap. Above 5,000 volts five-centimeter spheres are used. A resistance of 15,000 ohms may be placed in series with the sphere gap to reduce burning.

Low-Voltage Transformer for Boiler-Inspection Light

By Edward Swan

DANGEROUS electric shocks have been obtained from 110-volt lamp circuits while working inside of boiler, waterwheel casings, water tanks and other grounded structures. In some cases these shocks have caused death. To eliminate the possibilities of such shocks, we have been using a six-volt light supplied from a transformer connected to the 110-volt lighting circuit. The six volts is perfectly safe, and there are no batteries to run down or to be recharged.

For the primary coil of the transformer a 110-volt contactor coil was used containing about one-half pound of No. 17 wire. About eleven feet of No. 11 wire was used in the secondary coil. The core iron of an old transformer was used to make the core for the low-voltage transformer. This iron was cut L-shaped and assembled in the contactor coil, after which the core was insulated on the opposite side and the secondary coil was wound in place. Unless the number of turns in the primary coil are known, the turns in the secondary coil are more or less a matter of trial. In this case there should be about one-twelfth the number of turns in the secondary that there are in the primary. The general arrangement of the core and coils is shown in the figure.



Transformer completely assembled and the coils mounted on the core

When assembling the core, the laminations are staggered so as to make lap joints, and they are clamped together to reduce noise. The clamps are also used to hold the core in the case.

On the 110-volt side about ten feet of extension cord with an attachment plug was used. On the six-volt side the extension light can be made of material that best suits the conditions, but in my case a double-contact flush-type automobile dash socket was used. The cord should be made long enough to suit the condition under which the light is to be used. As this equipment is primarily a safety device, it should be thoroughly insulated.

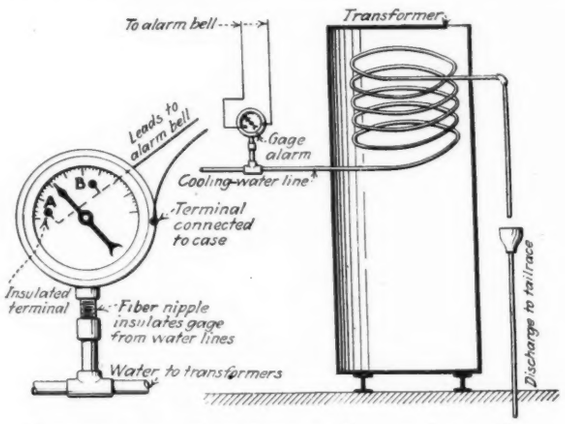
Electrical Applications

Cooling-Water Flow Alarm for Transformers

By J. Jacobs

AS THE capacity of power transformers increases, greater care must be exercised to safeguard them from overheating. In a hydro-electric station river water was used for cooling the transformers. The water carried so much mud and clay that the alarm contact points on the flow indicator would foul and corrode and the alarm would be rendered useless.

The station electrician devised an alarm that is both



Pressure gage flow alarm indicates obstructions to cooling water

simple and inexpensive. As indicated above, an insulated contact *A* is put in the dial of the pressure gage on the flow line. If the water flow decreases to the danger point, the gage hand drops back and makes contact with the insulated terminal and rings the alarm bell.

In our case the greatest possibility of water stoppage is the cooling-water lines from the screens at the intake end up to the transformer. The transformer coils are of brass and very little dirt collects in them. There is only a short piece of iron pipe to take the cooling water from the transformer to the open discharge, therefore there is little danger of stoppage here. As the gage alarm is installed close to the transformer, this leaves little likelihood of stoppage from this point on through the transformer coil. However, we had planned that, should it ever become necessary, another insulated terminal *B* would be put on the gage alarm so that in case of stoppage on the discharge side the rising pressure would ring the alarm just as for decreasing pressure. It is quite possible that if this gage is installed in some other plant under different conditions, it might be well to guard against the danger of dirt collecting in the cooling coils by including the second insulated terminal.

We have found the gage alarm very effective, and it gives one the assurance that, so far as the cooling water supply is concerned, the transformers are safe. One of the best ways of preventing trouble is to search out what might be the cause of failures and take the necessary precautions before something happens. The pressure alarm is an example of such foresight.

Meeting Hydraulic-Elevator Peak-Load Demands

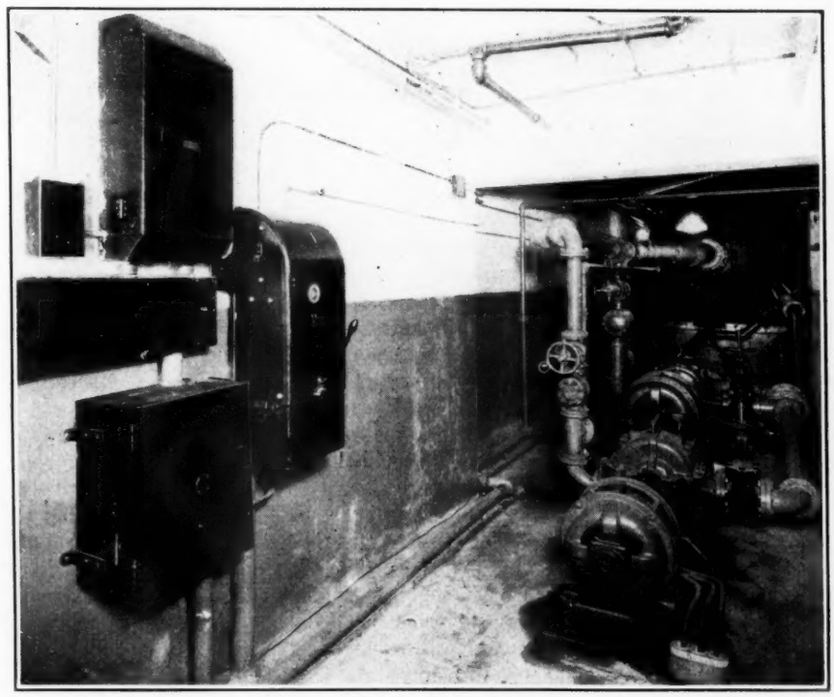
By D. L. Furness*

FOR maintaining water pressure for a hydraulic elevator there was recently installed in the Sherer Building in Worcester, Mass., a 30-hp. 1,800-r.p.m. 220-volt three-phase 60-cycle high-reactance motor direct connected to a centrifugal pump controlled by a magnetic across-the-line starting switch and pressure governor. In addition, there was installed a standard squirrel-cage induction motor rated 75-hp., 1,800 r.p.m. 220 volts, direct connected to a centrifugal pump and controlled by a hand-starting compensator.

In operation the large manually controlled motor runs continuously during the day, being started and stopped by an attendant morning and night. During rush hours, when the pressure demand is in excess of this motor's output, the pressure governor starts and stops the 30-hp. motor to take care of peaks. On Sundays and holidays the large motor is shut down and the automatic equipment meets all requirements. Except for central-station auxiliaries the 30-hp. motor is probably the largest induction motor for full-voltage starting, automatic operation, taking power from central station lines in New England.

*General Electric Company, Boston, Mass.

Motor and control equipment for operating hydraulic-elevator pumps



Remodel the Ice Plant

a Southern Engineer Advises

A description of the steps taken in the remodeling of a Southern ice plant—Savings made by insulating steam lines—Remodeling ice-tank system improved capacity

By C. T. Baker

Consulting Engineer, Atlanta, Georgia

WHILE industrial power plants are being remodeled to obtain greater efficiencies, a still greater opportunity awaits the engineers and managers of ice plants who venture upon rehabilitation. This is for the reason that in the manufacture of ice the power item is the chief one in the cost per ton of ice manufactured, and a power saving of 10 per cent means a reduction of from 5 to 7 per cent in the manufacturing cost.

During the month of May, 1923, the writer was called in to make an investigation and report on an ice-making plant, which was operating a creamery, an ice-cream plant and a bottling business. Conditions were very bad, and in addition to the failure of the plant to produce its rated capacity, the management was faced with the problem of high fuel cost, which was of such magnitude as to affect earnings materially. After a careful survey a plan of operation and improvements was outlined. However, owing to the local conditions it was necessary to work out the improvements over a period of two or three years rather than attempt to carry them out in one year.

The Power-Plant Equipment

The equipment then in the plant consisted of three horizontal tubular boilers 72 in. in diameter, 18 ft. long, which supplied steam to a Corliss engine driving a vertical single-acting ammonia compressor with twin cylinders 13 in. in diameter and 24-in. stroke. As the compressor had a broken crankshaft, only one cylinder could be used. Steam was likewise supplied to a 9x12-in. twin cylinder vertical single-acting compressor driven by a Corliss engine and to a 18x18.5-in. uniflow engine driving a 13x13.5-in. horizontal double-acting compressor through a flange coupling.

Part of the auxiliaries in the plant were driven from a slide-valve high-speed engine of about 20 hp., the rest being motor driven from central-station current. The exhaust from the several engines was connected to one common main that delivered all the steam through an inclosed feed-water heater to a battery of atmospheric steam condensers on the roof of the building.

The ammonia compressors discharged the ammonia gas through two separate discharge lines connected to a common discharge header on the ammonia condensers. The condensers were of the atmospheric bleeder type, there being ten stands 16 pipes high and two stands 14 pipes high, all made from 2-in. pipe.

The ammonia condensers were supplied with water from an atmospheric cooling tower which received its makeup supply from a deep well located on the premises. A separate water supply was provided for the steam condensers.

There were installed two ice-freezing tanks, one a distilled-water tank equipped with three hundred and sixty 300-lb. ice cans arranged twenty cans wide by eighteen cans long, and equipped with two 18-in. horizontal brine propellers.

One Tank Uses Raw Water

The other was a raw-water tank containing three hundred and sixty 300-lb. cans arranged eighteen cans long by twenty cans wide.

A low-pressure air system was used for aërating the water in the cans. Distilled water for one of the tanks coming from the exhaust steam condensers was cooled before going to the pure-water storage tank by being passed through four stands of atmospheric distilled-water coils 8 pipes high and 18 ft. long.

The feed water was taken from a receiving tank into which the warm condensing water from the steam condensers was delivered and was pumped to the boilers through the inclosed feed-water heater, which raised its temperature to about 185 deg. F.

Reasons for High Fuel Costs and Loss of Capacity

One of the causes for high fuel costs and undercapacity was found to be excessive condensing pressures. During the hottest part of the day the condensing pressure often reached 240 lb. gage.

Investigations made to determine the reasons for this condition disclosed that the trouble was caused, primarily, by air in the system and, secondarily, by improper cooling of the condensing water in the atmospheric cooling tower. This latter was due to the poor arrangement of the shelving, which did not permit the breaking up of the water into minute particles in its descent through the tower.

It was discovered that the water was not being evenly

distributed over all the condenser stands and the stands were not stripped for the purpose of insuring that all water delivered to each stand was evenly distributed to each pipe.

The small 9x12-in. compressor was used to refrigerate the ice-cream hardening room, which room was carried at a temperature of about zero and required a suction pressure of from 7 to 8 lb. gage to insure that there would be a sufficient heat head or temperature difference between the evaporating ammonia in the cooling coils and the room itself. Often the suction pressure was allowed to fall below zero, and since the piston rods were badly scored and the packing in poor condition, air was frequently drawn into the system through the stuffing box, which, of course, in time caused excessive head pressures. The plant was much in need of ammonia, since most of the time when every machine was being operated, the ammonia did not stand high enough in the liquid receiver to seal the liquid outlet from the same. This meant that during such times gas was passing the expansion valve.

How the Trouble Was Remedied

To remedy this trouble, the small compressor was completely overhauled; this included the grinding of the suction and discharge valves, the turning down of the piston rods and the packing of the stuffing box with new packing. In order also that the suction pressure on the hardening-room coils should be carried as high as possible, these coils were defrosted and arrangements were made for the regular defrosting of the coils whenever it became evident that it was not possible to obtain satisfactory cooling at a suction pressure of 6 to 8 lb. gage.

Further investigations disclosed that at some time in the history of the plant a liquid trap had been connected to the suction outlet of the hardening-room coils, with a drain pipe provided to drain the liquid carried over by the suction from these coils back to the liquid header of the coils. However, this liquid trap was placed so low that there was not sufficient static head for the liquid to drain back to the coils, with the result that the trap remained full of liquid and tended to obstruct the suction outlet and to cause liquid to be siphoned over to the compressor.

An Accumulator Was Installed

This trap was removed and a larger liquid trap, or accumulator, was placed on the suction pipe leading to the compressor, being located several feet above the top of the coils with a return liquid line of ample cross-section area.

Fortunately, this liquid accumulator could be conveniently located in an ice-storage room adjacent to the hardening room; this permitted it to be placed several feet above the hardening-room coils and assured positive drainage of the liquid.

It was decided to use this small compressor on the hardening room exclusively, operating it during the summer season from 18 to 20 hours each day. This compressor was, however, cross-connected with the other two machines on both the suction and discharge sides in order that any one machine could be used on either the freezing tanks or ice-cream hardening room.

After these changes had been made, purging operations were continued until the system was free of non-condensible gases. As a result the condensing pressures approximated closely the theoretical pressures to be expected with the prevailing water temperatures.

It was found that the quality of neither the raw-water nor the distilled-water ice was up to standard. In the case of the distilled-water ice investigations showed the trouble to be caused by cylinder oil which was finding its way into the distilled-water forecooling tank from the distilling system. In the case of the raw-water ice, the poor quality was due to improper filtration of the water and to the somewhat obsolete method of introducing air to the cans.

To prevent oil from reaching the distilled-water forecooling tank, the atmospheric distilled-water cooling coils were at once equipped with live-steam connections and drains, and these coils blown out regularly once a day. Considerable cylinder oil passed with the exhaust steam through the oil separator to the atmospheric steam condensers and from there to the reboiler. Since the distilled water leaving the reboiler was about 212 deg. F., the oil was of course very fluid and easily flowed along with the water from the reboiler to the distilled-water coolers.

At this point the distilled water was cooled to about 80 deg. F. and the cylinder oil, also being cooled, would adhere to the pipe surfaces until a considerable quantity had collected, then it would pass over in large lumps to the distilled-water storage tank. By blowing these coils daily with live steam, this trouble was overcome.

Of course it was necessary to clean the distilled-water storage tank and the entire oil distilling system before all the trouble was removed. It was found in going over the exhaust piping that the oil separator, which had been placed on the main exhaust line for removing the cylinder oil from the exhaust steam, had been placed between the steam condenser and feed-water heater, which meant, of course, that the feed-water heater was not protected and a great deal of the oil was being deposited on the tubes of the heater. Improvement in raw-water ice was made by altering the filtering apparatus, and at the close of the season improved aërating equipment was installed on this tank, eliminating the troubles experienced and resulting in a first-class quality of ice.

It was found that no insulation had been provided, either on the steam piping or on the low-temperature ammonia piping. As a result of this a great deal of loss in fuel, as well as in refrigerating capacity, was being experienced.

The Boiler Was in Bad Shape

The boiler brickwork was so bad that there was a considerable fuel loss, and under the conditions prevailing at the time of the investigation it was necessary to operate two boilers to carry the load.

The fuel consisted of run-of-mine coal supplemented by shavings of a near-by mill, but even with part of the fuel costing very little, the fuel cost per ton of ice was abnormally high.

As stated elsewhere, it was possible to carry out only a part of the necessary improvements during the summer months, but those that were made resulted in a decided gain in output as well as in fuel economy. The following year the old cooling tower, which had by that time deteriorated to where it was not only inefficient but in a dangerous physical condition as well, was replaced with a modern tower erected where the best air circulation prevailed.

The placing of this tower in service resulted in two things—there was a decided improvement in condensing pressures and the loss of cooling water by seepage to the ground from a leaky collecting basin was eliminated.

Following the installation of the new cooling tower the old atmospheric ammonia condensers, which were also in rather bad condition, were replaced with a battery of two shell-and-tube condensers 30 in. in diameter by 14 ft. high, erected on a combined reinforced-concrete foundation and collecting basin. The water from the cooling-tower basin was delivered to the top of these condensers by gravity, passed downward through the tubes to the basin below, where it was picked up by the water circulating pump and delivered again to the top of the tower for recirculation. This permitted the removal of the old tower and the superstructure which supported the old ammonia condensers, adding greatly to the appearance of the property and at the same time permitting much freer circulation of air through the new tower.

The new condensers were fully equipped with gas, liquid and water headers and were connected so as to permit a condenser to be taken out of service without interfering with the other. Each condenser was equipped with a spring-loaded relief valve for protection in case of excessive pressure. When placed in service, this arrangement of cooling tower and ammonia condensers permitted the lowest possible condensing pressure consistent with the temperature of cooling water leaving the tower. This condition, together with the fact that the system had been thoroughly purged of non-condensible gases, resulted in the lowering of the condensing pressure from an average of 225 lb. gage in 1923 to 165 to 175 lb. in 1924. It requires no stretch of imagination to appreciate just what this meant in the way of reduction in horsepower developed in the steam cylinders of the ammonia compressors.

The Small Engine Was Shut Down

As it was necessary to operate the uniflow-engine driven compressor continuously during the ice season, and since it was much more economical in the use of steam than the slide-valve engine which furnished much of the auxiliary power, a lineshaft was erected on a steel girder and arranged to receive power from a pulley placed on the crankshaft of this engine.

From the shaft, power for the various auxiliary equipment was taken off by belt. This change resulted in a saving of between 700 and 800 lb. of steam an hour. For emergency use the lineshaft could be operated by the slide-valve engine.

The uniflow engine was overhauled and put in first-class condition and the ammonia cylinder fitted with the latest type plate valves. This permitted the speeding up of the compressor to the speed for which the machine had been designed to give its maximum steam economy. It is interesting to note that the cost of the steel girders and necessary pulleys, hangers and other new material required to operate the auxiliaries from the compressor flywheel, was approximately $200 delivered and installed.

In order that all three ammonia compressors might be in first-class condition and able to operate, if needed, at full capacity, a new crankshaft was installed in the 15x24-in. vertical machine, and at the same time the steam and exhaust ports of the Corliss cylinder were rebored and fitted with new valves, as the old valves and ports were badly worn.

With this work completed, both compressor cylinders were connected up and the machine operated until all new bearings were well worked in.

The cost of this job was approximately $1,200, but was justified by the increased plant capacity, insurance against loss due to the breaking down of one machine and improved steam economy.

As one of the three boilers was in a bad physical condition and as the insurance company had greatly reduced its allowable working pressure, a new unit was decided upon.

A 72-in. x 18-ft. boiler designed for 150 lb. safe working pressure was purchased. This was set in a brick setting, with the bottom of the shell placed 48 in. above the top of the grates in order to obtain increased furnace and combustion chamber volume over that of the old boiler, which was set only 28 in. above the grates.

At about the same time, the new boiler was installed a new feed-water heater of the open type, having a water heating capacity sufficient to raise the feed-water temperature to from 200 to 205 deg. F. from the available exhaust steam, was purchased to replace the old inclosed heater, which was too small for the feed-water requirements.

The Plant Changed to Raw-Water Operation

Owing to certain disadvantages in operating a plant part distilled and part raw water, the distilled-water tank was changed over to raw water, with each of the 360 cans fitted with center drop tubes and connections for low-pressure air.

With this change the old atmospheric steam condensers were removed and the exhaust steam from the various engines and pumps was allowed to escape directly to the atmosphere with the exception of the amount condensed in heating the feed water. This reduced the back pressure on all the steam cylinders since much of the original exhaust piping was removed and a much shorter exhaust main with fewer right-angle turns substituted.

The cutting out of the distilling system, including a large uninsulated distilled water reboiler, the distilled water pumps and the cooling coils, further reduced the steam requirements, with the result that when the improvements were completed it was found that, in place of two boilers being required to carry the summer load, one boiler carried the entire load with ease and did so a large part of the time with shavings and sawdust secured from a near-by mill and at a cost much less than the cost of coal.

Insulation Was Put on the Piping

The exposed steam piping was carefully insulated and the brickwork of each boiler setting given a heavy application of prepared boiler coating, which reduced the air leakage losses through the brickwork to a remarkable degree. Stack dampers were installed and the fireman instructed in their use, all of which was favorably reflected in the fuel bill.

Later, a modern water-softening plant was installed for treating and conditioning the feed water before being fed to the boilers. This not only greatly improved the boiler efficiency due to the elimination of scale from the heating surfaces, but also reduced the cost of boiler cleaning and repairs materially.

The water supply for boiler feed and for makeup in

the cooling tower was taken from a deep well on the premises. Water for ice making and certain other purposes about the plant was taken from the city mains through a meter, and at certain seasons of the year the cost of city water was considerable. As this cost was an item charged against ice production, it was desired to eliminate it, if possible to do so, by the use of water from the plant wells.

An opportunity was afforded for the purchase, at a very reasonable price, of a cypress tank that had never been used. This was used as a strong tank for the storage of surplus water from the wells over and above the condensing and feed-water requirements. There was no reason why the well water should not be used for ice-making purposes, since chemical and bacteriological analyses showed that it was entirely suitable for such use.

With the tank was purchased a steel tower 27 ft. high for carrying it. After the installation was completed, which represented an outlay of approximately $1,000, it was found that the saving in city water averaged nearly $100 a month.

Since the completion of the well-laid-out plans of plant rehabilitation started some years ago, the operating results have been most gratifying and the savings in operating expense have paid large returns on the money invested in the improvements.

One of the greatest items, however, was a change in chief engineers which resulted in the placing of a progressive up-to-date man in charge.

Operating an Ice Plant with Inexperienced Men

By H. C. Cunningham

WE HAVE, I think, a rather unusual operating condition in our plant. Two Diesels drive generating units furnishing power and light to a Florida city of 2,500 and supply energy for a 25-ton electrically driven raw-water ice plant.

These two plants are in separate buildings, but are connected with large sliding doors. We have three operators with eight-hour shifts and a change of shifts every two weeks. No helpers are furnished; the operator does his own cleaning up, ice pulling and can filling; in fact, one man per shift does all the work. Half-hourly readings are taken in both plants. In the power plant this consists of switchboard instruments, flow-meters and exhaust-pyrometer readings. In the ice plant readings are taken of the suction and discharge pressures and temperatures of the brine-tank and storeroom temperatures and of the ammonia liquid level in the brine cooler and in the ammonia receiver. All bearings are inspected hourly in both plants. The power plant does not boast a voltage regulator, the absence making an additional amount of work for the busy operator.

We have found that an experienced operator will not stay any length of time, as there is too much hard work to suit him. We find that the green inexperienced operators give the most satisfaction. They do all that is expected of them and are ready to do even more in order to get the practical experience; that is, the really ambitious ones do; if they are not ambitious, they last but a few days. Of course they make mistakes that are sometimes expensive, but so do some of the so-called experienced operators. Usually, with a month's careful coaching they are capable of handling a shift if there is someone within calling distance to help them in emergencies. In order to get the ones that are really ambitious and discourage temporary job hunters, we make the wages very low until they are capable of taking a shift. Usually after 1½ to 2 years they start looking for bigger and better jobs, but we expect this.

Inasmuch as I am responsible for operation in this plant and have had experience with both experienced and inexperienced operators, I feel that in this case the "green" operator gives the better results.

Short Coils with an Accumulator

WITH the gravity feed system using an accumulator, better results are secured with the short coil. If they are too long, the back pressure will be too great and the ammonia will not go through but will back up instead. The gravity feed can be used after the tank has cooled down.

It is of material advantage to divide up the coils. Sometimes they are divided horizontally. For instance, one company makes two separate assemblies of six pipes each, if the coil is 12 pipes high, and feeds an excess of liquid ammonia, so that the entire coil is flooded. Then the excess liquid coming over will be fed back again, which overcomes the necessity of careful figuring as to the ammonia admitted through the expansion cock.

A rational way for counteracting excessive discharge of unevaporated liquid from short coils is to use correspondingly smaller pipe, ¾-in. or even ½-in. pipe, if necessary, instead of adhering to coils made of 1-in. or larger pipe. A short coil of large pipe contains more liquid than its surface can evaporate, hence the ratio of volume to surface should be decreased.

Power Conversion Puzzle

C	O	A	L
H	E	A	T

MOST of the heat developed in the power plants comes from coal; but the point is can the reader perform this act of conversion by beginning with the word "coal" in the chart and by changing one letter at a time, form other words in the blank spaces to finally produce "heat." After trying, turn to page 786 for one solution.

IDEAS FROM PRACTICAL MEN

For the exchange of practical information and ingenious expedients in operation and maintenance of plant and equipment

How Kerosene Is Used to Keep Fuel-Oil Gage Glasses Clean

ENGINEERS who have had experience in using fuel oil either under boilers or with Diesel engines know how difficult it is to keep the gage glasses clean on the oil tanks so that the oil level can be readily observed.

It occurred to me that our method of overcoming this trouble might be of interest to other engineers. We inject a little kerosene in the glass above the oil, through the pet-cock on the top of the gage. The kerosene floats on the top of the oil and keeps the glass clean for a long time.

O. J. JONASSEN.

Brooklyn, N. Y.

Assembling a Waterwheel Generator Under Difficulties

MEETING and overcoming difficulties is part of the erector's job, and many variations from standard procedure must be made to meet local handicaps. A power company designed a power house for vertical generators driven by waterwheels. Later it was decided to lengthen the generator shaft and bolt the wheel directly to a forged flange on this shaft extension.

This made material savings in costs, but it was overlooked that the height of the crane rails had been determined so the original shaft would swing over the top of the stator frame and that the new shaft was several feet longer. The erector discovered this error when erecting the machines and had to get the fields in as best he could. The problem was solved as shown in the figures.

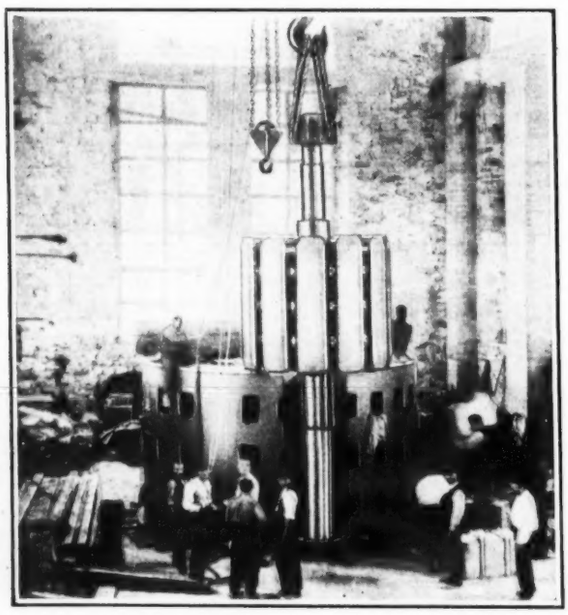


Fig. 1—Rotor being swung into position over the two halves of the stator

The two sections of the armature were erected on temporary blocking as shown in Fig. 1, with space enough between them for the coupling to enter. The field was then swung in and left hanging on the crane while the two halves of the armature were jacked and bolted together and to the baseplates.

The cribbing, which had been made ready previously, was then securely placed as shown in Fig. 2, to support the rotor on the stator frame. The joint coils were installed and connected with the field resting on this cribbing.

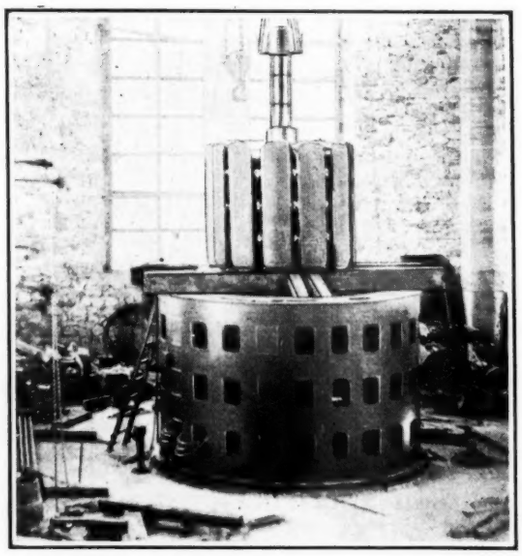


Fig. 2—Rotor supported above the stator while the joint coils are being installed

The field was then lifted with the crane, the cribbing removed and the field lowered into place.

Repairs to the armature or periodic cleaning can be accomplished by raising the field and blocking it as in Fig. 2, and the waterwheel runner can be lowered on the seal rings by jacks and bolts when necessary.

Schenectady, N. Y.

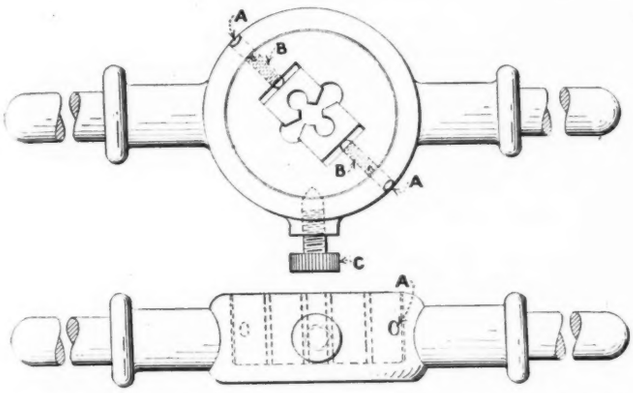
N. L. REA,
General Electric Company.

Change Made in Stocks and Dies to Facilitate Adjustment

THOSE who have occasion to thread bolts with the usual stocks and dies will, I believe, appreciate a little change in them that I have made.

Ordinarily, to adjust the dies it is necessary to remove the die plate from the stocks so as to get at the adjusting screws *BB*. When in a hurry and the dies are oily and covered with chips, this is a nuisance and a loss of time, because several adjustments may be necessary to set the dies just right.

My plan is to turn the die plate about 45 deg. from its normal position and drill holes *AA* through the frame, through which the screws in the plate can be adjusted



Adjustment screws are accessible through holes in stock

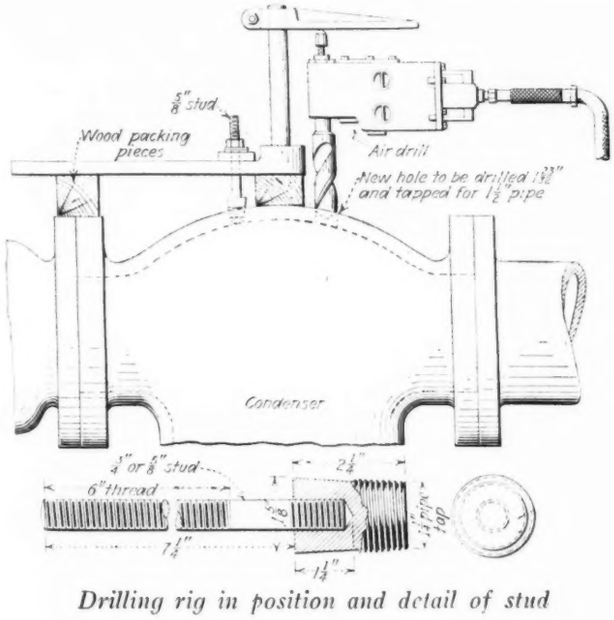
without removing the die plate from the frame. A new countersink has to be drilled for the clamping screw *C*.

Long Beach, Calif. E. J. JORDAN.

Pipe Plug With Long Holding Stud Used to Secure Drilling Rig

NOT infrequently one encounters difficulty in fastening a suitable drilling rig for boring holes for additional pipe connections or bracket mountings on machines.

On a recent job we overcame this trouble by making up a 1¼-in. pipe plug with a long stud to hold the drilling



Drilling rig in position and detail of stud

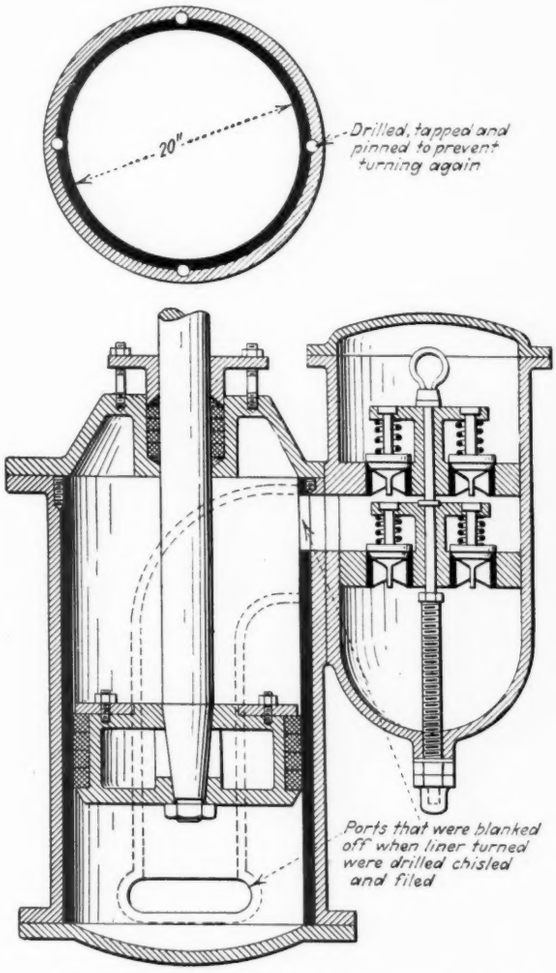
rig, or old man, as shown in the illustration. We have carried this idea still farther by using plugs in sizes from 1⅛ up to 2½ in. On the sizes below 1⅛ in. we have made the complete plug and stud from steel rod to suit. This stud comes in handy when holes are to be drilled in flanges with blind tapped holes or when drilling out broken studs.

Holtwood, Pa. G. H. ENGLEHART.

An Emergency Repair That Became Permanent

SOME years ago I was chief engineer of the old dynamite cruiser U.S.S. "Vesuvius," which had been converted into a torpedo experimental ship.

One of our two main feed pumps failed to deliver any water one evening, although the pump seemed to be running all right. After a systematic search for closed valves, etc., it was discovered that the liner in the water end had turned, completely blanking off the ports. No


20"
Drilled, tapped and pinned to prevent turning again
Ports that were blanked off when liner turned were drilled chisled and filed

Liner was pinned in place to prevent turning

spare liner was at hand nor was there material and equipment to make one. There was the possibility that if this liner was withdrawn from the barrel, it would be injured or too loose a fit if inserted again; so the following method of repair was effected with very good results.

The liner was drilled, tapped and pinned as shown in figure, to prevent it from turning again. Holes were drilled through the liner to communicate with the ports blanked off and then enlarged by chiseling, the ragged edges being filed smooth in order to prevent the plunger packing from catching and tearing. The pump was then put in service and operated as well as ever and was still going strong when I left the ship two years later.

Boston, Mass. EARLE S. NASON,
Chief Machinist U. S. Navy Yard.

COMMENTS FROM READERS

In which those who agree and those who disagree, with either authors or editors, are afforded an opportunity to express their views

Recommends the Shotgun As a Slag Remover

IN THE March 13 issue Richard N. Seldon asked for suggestions in clearing slag from boiler tubes. I should like to suggest that he try an ordinary shotgun loaded with No. 12 bird shot.

A raking shot is more efficient than a straight-on shot. It is unnecessary to reduce the load on the boilers, and no injury can come to the ordinary steam boiler from this size bird shot. A few shots well placed every few days should keep his boiler clear of slag.

Hartford, Conn. T. H. SOREN, Vice-President,
The Hartford Electric Light Company.

* * * *

Pitting of Turbine Bearings

I HAVE been much interested in the various letters referring to the inquiry of J. W. Baker, as to what caused the pitting of the journals of a new turbine-generator set.

In 1914 I experienced the same trouble on a turbo-geared generator, the first signs being shown by the oil. Some changes were made in the oil feed and drainage system, but the trouble still existed. Pitting was then noticed on the journals and also on the reduction gears.

A small amount of metal was machined off the bottom of the bearing pedestal and a piece of sheet insulating material placed between the pedestal and bedplate. The holding-down bolts and also pedestal pipe connections, were insulated by fiber bushings and washers. By thus insulating the pedestal, the trouble was corrected. Since the unit installed by Mr. Baker was new, the pitting was probably done in the manufacturer's test shop, as has been suggested by other readers. G. S. BARNES.

Mountain Park, Alta., Canada.

* * * *

Bending Pipe or Tubing

REFERRING to the inquiry of W. A. Robertson in the Feb. 28 issue on bending pipe, the factors of elongation or compression of metal need not be considered when the following method of calculation is used for finding the exact length of pipe or tubing to be cut or threaded before bending.

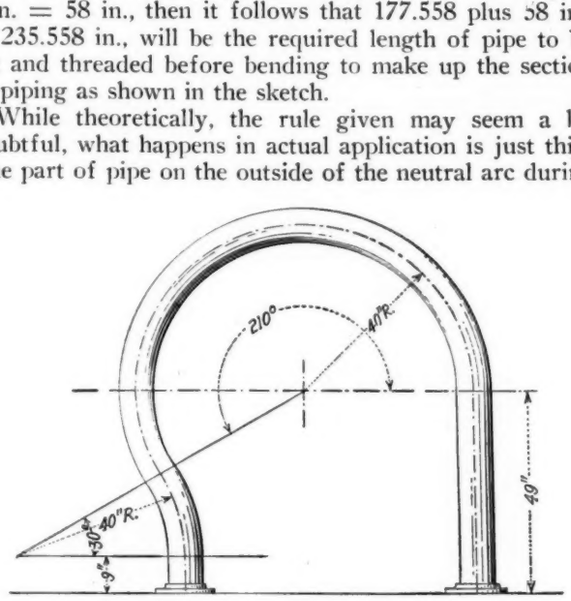
Two requirements to be considered are the outside diameter of the pipe and the arc or arcs of a circle to which the pipe is to be curved.

The rule is as follows: Calculate the neutral arc or arcs, to this result add the length of straight pipe required on each end of the curved part, and the result will be the exact length of pipe required.

Example: Calculate the required length of 8-in. pipe to be cut and threaded before bending to dimensions, as shown in the sketch; neutral radius of large arc is 40 in.; neutral radius of small arc, 40 in.; length of straight pipe on small arc, 9 in.; length of straight pipe on large arc, 49 inches.

Both arcs having the same radius, the sum of the degrees of the two arcs will be the part of the circle whose radius was 40 in., or diameter 80 in. The 210 deg. plus the 30 deg. equal 240 deg., or $\frac{240}{360}$ or $\frac{2}{3}$ of an 80-in. diameter circle. Diameter 80 in. $\times$ 3.14159 equals 251.3272 in., or the whole circumference, but this particular case $\frac{2}{3}$ of the 251.3272 equals 177.55 in., and adding the straight pipe that is required, or 49 in. plus 9 in. = 58 in., then it follows that 177.558 plus 58 in., or 235.558 in., will be the required length of pipe to be cut and threaded before bending to make up the section of piping as shown in the sketch.

While theoretically, the rule given may seem a bit doubtful, what happens in actual application is just this: The part of pipe on the outside of the neutral arc during



Dimensions of pipe bend

the process of bending gives way to elongation, or stretches out, while the part of the pipe on the inside of the neutral arc submits to compression. Of course, to have the elongation equal to the compression, it should be understood that heating the pipe as nearly even as possible will materially aid in making the perfect bend. The same rule holds true when bending pipe or tubing cold. H. W. BROWN.

Oswego, N. Y.

* * * *

"How About the Man?"

I SHOULD very much like to rewrite the editorial that appeared in *Power* of April 10 under the title "Let the Machine Do It." Plant officials are so absorbed in the mechanical progress of industry that the human side is lost sight of entirely.

When a machine is designed to do with one man the previous work of ten, what are we going to do with the other nine? And strangely, usually the machinery throws out of employment highly skilled labor, trained to do that particular job, not common labor. These men have high standards of living and a comparatively large pur-

chasing power. They do not readjust themselves so amenably to a lower scale.

The April issue of *World's Work* gives an interesting editorial on causes of unemployment and includes this table:

Industry	Workers in Thousands 1919	1925	Index 1925 (1919 = 100) Workers	Output	Output per Worker
Manufacture	10,689	9,775	91½	128½	140
Agriculture	11,300	10,500	93	108	118
Mining	1,065	1,065	100	133	133
Railways	1,915	1,744	91	104½	115
Total or average	24,964	23,084	93	120	129

Noteworthy are the figures for manufacture, a decrease of 8½ per cent in workers with an increase of 28½ per cent in production, 40 per cent increase per worker. Some of the outstanding manufacturing corporations that have effected greatest mechanical development with apparent tremendous profits have certainly helped their stockholders. These will probably be hardest hit when the pendulum swings back as the buying power of the workman is lowered.

This is good food for editorial thought. The United Gas Improvement Company of Philadelphia, the state of New York, and many other establishments have rearranged their construction programs to help present unemployment conditions. Some men advocate more wages spread over more individuals in five-day weeks, or in more equal time distributions. *World's Work* offers several suggestions. I believe this is the problem of the day, as what does it profit us if we have low prices with improved machinery, if people cannot buy the products.

Dayton, Ohio. F. M. REITER.

[See the editorial "What About the Man?" in the front of this issue for comment on some of the thoughts in Mr. Reiter's letter.—Editor.]

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The Past and Present Chief Engineer

I FOUND the article entitled "The Past and Present Chief Engineer," by Elmer S. Smail, in the March 13 issue of much interest. That the situation is as he describes and that the public does not know the modern chief engineer, is unfortunately true. The fault, however, is far from being the public's, but is rather the result of a too intense desire on the part of the chief engineer to serve his fellow-man in the field and manner he knows best—namely, engineering.

The sincerity of his intentions leads the chief engineer to devote that part of his leisure which he spends away from his family to the pursuit of further engineering knowledge. He belongs to the local engineers' club, he is a member of the engineering societies and he concentrates his reading on current technical literature. He is the ideal professional man—all his energy is given toward increasing his knowledge along strictly technical lines.

Yet the true value of any knowledge lies not in acquiring it, but in putting it to use. It isn't so much a matter of what you know, but what opportunities you create for putting what you know to the maximum use. Even in the strictly engineering sense, many an older engineer in the ranks knows more in terms of accumulated facts than his chief, but he is where he is because he has never learned to put these facts to work for him successfully. Hard as it is to believe, this same chief, however, will continue to concentrate on purely technical facts, entirely oblivious of the bigger opportunities he is foregoing by not trying to generalize his education more, so that he can seek and find a wider application for his engineering training.

In seeking to meet and establish contacts with professional men outside of the engineering field, as bankers, lawyers, managers and the public in general, he is decidedly not wasting his time—either from his own personal viewpoint or that of his profession. Rather he is doing the pioneering work so badly needed at present, in giving the general public a chance to know the chief engineer as he really is, and what is more, giving him in turn an opportunity to study general problems in the light of his specialized training. There is no reason why the number of engineers in the major executive positions in industry should not increase at a rapidly accelerated rate, and this general contact is one of the first steps for the profession as well as the individual necessary to attain it.

This is an age of publicity and advertising. The success of any product lies in getting the public acquainted with its merits; so it is with the engineer. It behooves him to cease hiding his light under a bushel and face the world, confident in his past performances and even more so in his future ability to contribute still greater and more varied achievements to the story of the world's progress.

Brooklawn, N. J. J. W. GARDINER.

* * * *

Hazards in Coal and Ash Handling

COAL and ash handling are every-day routine matters involving operations that are dangerous, but too frequently the dangers are ignored by the laborers concerned and those responsible for their safety. Precautions to be taken are quite simple, but perhaps the best way to tackle the problem is to discuss the dangers and attract attention to them.

Where coal is dumped from a railroad car into a bin and delivered by gravity to a conveyor, there is always the possibility of the laborer's being caught in the moving coal and drawn into the coal jam, to be crushed by the weight of the coal or suffocated by it and the remote chance that he may be drawn into the coal crusher. In fact, a case occurred in Chicago, in a plant famous for its safety methods and operating practices, where a laborer was missed and, after a search was made, his mutilated body was discovered after having been passed through the coal crusher.

Obviously, such accidents are preventable through the use of either a screen or grid or by providing the coal handler with a prod or slice bar of sufficient length to permit him to reach down into the sliding coal without endangering himself. In many cases a rope should be tied around the worker's waist, while in other cases two men should work together.

Three men lost their lives in Chicago within a few weeks of each other while handling ashes. In all three cases the men were overcome by the fumes, dying from asphyxiation, from being smothered by the ash, and in one of the cases from severe burns. In ash handling, poisonous fumes have to be contended with in the ashpit, tunnel, and other restricted places where adequate ventilation is lacking.

Underground tunnels and ashpits are not the only hazards, however, for there are a number of cases on record where fatal accidents have occurred in elevated ash storage tanks. In many of these tanks the ash becomes "frozen." Breaking it up may necessitate one or more men climbing into the tank and cutting through the

mass with metal rods. When the ash begins to move, it is quite easy for the man to be caught in the avalanche and to be either crushed or buried in the moving mass, and there is the added hazard of dangerous fumes.

For protection in work of this character, it would seem that two men should work together, one staying outside the tank while the other goes into it after having taken the necessary steps to insure adequate ventilation. As an additional safeguard the man in the tank should have a rope tied around his body, so that his partner can pull him out should he be overcome by gas or be caught in the sliding ash. Where practicable, it is better still to furnish the men with long iron rods and so dispense with the need for climbing into the storage tank. There are cases where the gas mask is clearly indicated.

Distinction is usually made between accidents and occupational risks. In this connection it is well to bear in mind that ashpits, ash tunnels, etc., usually are laden with fumes that are injurious to throat and lungs. While the immediate effects may not be serious enough to incapacitate a worker, ultimately they may injure his health by causing pulmonary troubles. They are, therefore, hazards in every sense of the word and are just as real, although not so conspicuous or spectacular, as some other forms of accident.

With the steam-jet ash conveyor the same class of precautions as are used in connection with work upon high-voltage electric circuits, are desirable. The steam supply valve should be locked closed while men are working in any of the danger zones. A card should plainly state, "Men working—danger." This will prevent one man from turning on the steam while another is working on or in the conveyor system. Practically all the potential hazards mentioned herein can be prevented by the formulation of rules covering the situation, provided, of course, that they are strictly enforced.

The fact that unskilled men, and often foreigners, are employed for the handling of coal and ashes, makes it imperative for the official in charge to see that conditions are made as safe as possible and that the workers themselves understand the dangerous nature of the work and the importance of doing their utmost at all times to protect their own health and lives and those of their fellow men. K. RANKIN.

Chicago, Ill.

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Cleaning Diesel Oil by a Centrifuge

THE article on page 471 of the March 13 issue, by L. L. Cheetham, entitled "Cleaning Diesel Oil by Centrifuge," is most timely, as it describes a practice fully warranted by the results obtained. I have had the opportunity to observe not only the improvement effected in the operation of oil engines due to a cleaning of the fuel oil, but of the lubricating oil as well, and after a rather extended experience in this line I am convinced that under no circumstances should Diesel engines be operated without proper facilities for removing the impurities from the fuel oil before it is introduced to the engines, as well as for the periodical cleaning of the lubricating oil, which is continuously circulated to the bearings.

Another mistake too often made when installing Diesel engines, is that of not providing the air-compressor intake with proper air filters. Air that is introduced to the cylinder, either as injection air or scavenging air containing finely divided abrasive materials, will result in scored cylinders of both air compressors and engines.

Any engineer who has seen air filters cleaned after they had been in service for a few months, or even for a few weeks, in certain localities, and has observed the amount of foreign matter removed from the air as it passed through, must recognize the value of a good filter.

While speaking of air filters, a great many raw-water ice plants can also use such filters to advantage, since they will protect the air compressors and air blowers from damage and will also prevent the fouling up of the air dehumidifier system whenever used as in the case of the high-pressure system of water agitation.

In the case of the low-pressure system in which air is supplied by air blowers, it frequently happens that in some installations a great deal of foreign matter finds its way through the air mains and laterals and into the ice cans themselves.

Last summer, I happened to see two filters cleaned, which were removed temporarily from the low-pressure air blowers and which were found to contain lightning bugs, flies and other insect life, as well as a liberal amount of fine dirt. It is not hard to visualize the effects resulting from such conglomeration of materials entering the air distribution system of ice cans. C. T. BAKER.

Atlanta, Ga.

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Engineering "Word Pictures"

THE engineer or draftsman, when he has a new design under advisement, develops it in a logical and orderly process, from his first sketches of basic ideas and movements, through his assembly and installation layouts, and finally to its ultimate detailed production drawings. He makes his detail views and dimensions in accordance with his knowledge of shop practice and equipment; in other words, he speaks the language of the shop.

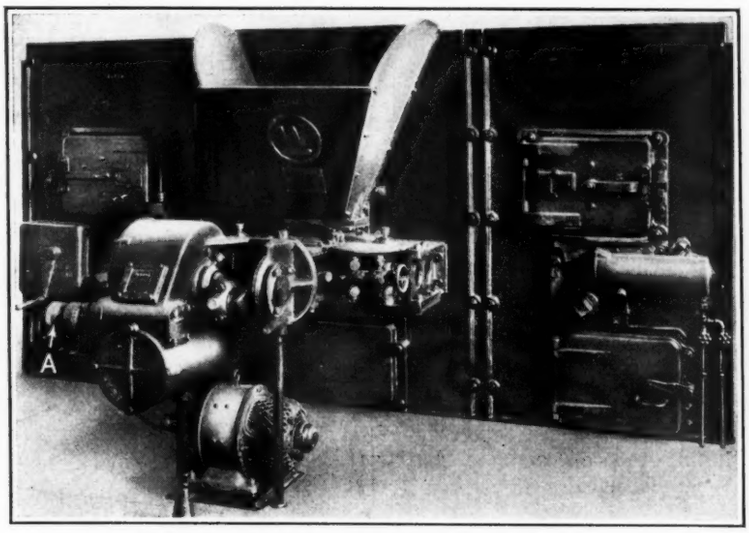
But when he comes to "sell" his idea, particularly by correspondence, he fails utterly to follow the same logical process he has evolved in creating his idea. To him letter writing is an odious task, and he excuses his weakness with the reflection that they're mighty good drawings and ought to be self-apparent to anyone who has a normal intellect. In so doing, he loses sight of the fact that, while he has taken full cognizance of the shop viewpoint in the manner in which he has prepared his drawings, it is utterly impossible to ensnare the executive or financial viewpoint in a drawing.

Yet, by proper consideration of the more general viewpoint—for engineering after all is a "service" function—he can definitely establish the need for his design, give facts and figures on the economy to be expected by its adoption and the resulting improvement of product to be realized. By building these up in the same logical sequence as his drawings, amplifying his statements with illustrations where necessary in the same manner as he would add special views to his drawing, and building up his detailed ideas into an installation assembly or conclusion, he can create a "word picture" that conveys his ideas to the executive as effectively as his drawings show them to the shops. And the tools and specialized knowledge he requires for the "word picture" are not nearly so involved as those he must possess to make a good drawing—namely, merely a knowledge of ordinary every-day English and a sincere concentration to apply the logical mind training he has already acquired.

Philadelphia, Pa. JOHN F. HARDECKER.

PLANT EQUIPMENT NEWS

New and improved equipment in power and industrial plant fields, and new applications of existing equipment



Single-retort stoker with mechanical drive

Mechanical Drive for Westinghouse Single-Retort Stokers

THE improved mechanical drive for single-retort stokers manufactured by the Westinghouse Electric & Manufacturing Company, South Philadelphia, Pa., consists of a speed-reduction gearbox together with the necessary connections for driving it by a suitable prime mover. It is used where the standard steam drive is not applicable on account of low operating steam pressure or because of other limiting conditions. The prime mover used with the mechanical drive must be such as to obtain the required speed range, such as a shunt-wound direct-current motor, a multi-speed alternating-current motor, a constant-speed alternating-current motor with a variable-speed transmission or a steam engine.

The speed worm has a machined double thread and is made of case-hardened steel. The speed-worm gear has phosphor-bronze machined teeth on a cast-iron spider and is mounted on the shaft with the power worm, which is a triple-thread worm cut from a steel forging. The power-worm gear is of cast-iron with machined teeth.

The speed-worm shaft runs in deep-groove ball bearings which take up both radial and thrust loads. The power-worm shaft is mounted on phosphor-bronze bearings to take the radial load. The thrust of the worm is carried by a ball thrust bearing. The crank is supported by three cast-iron bearings, one on either side of the power-worm gear and one outboard bearing.

All gears and bearings are immersed in oil except the crank bearings, which are lubricated by grease cups. The entire mechanism is inclosed in a compact housing and is so designed that it may be bolted to the standard retort flanges.

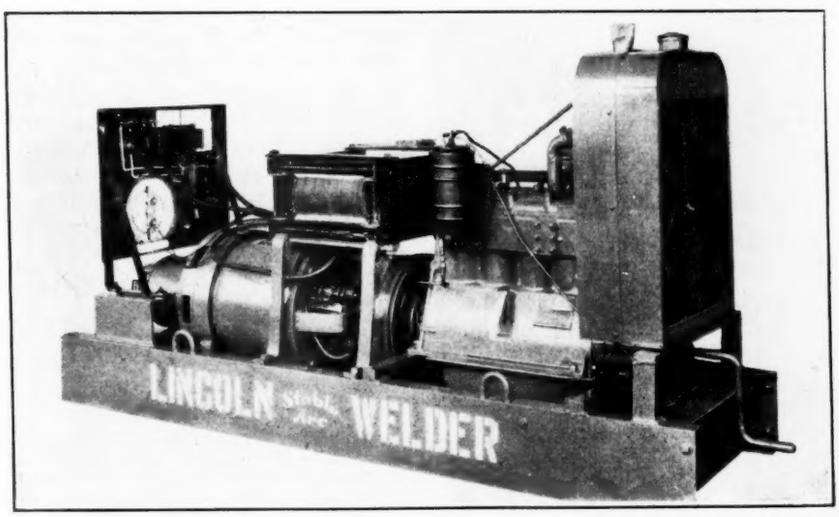
The gearbox is designed for a chain drive. The gear reduction is such that the wide range of speed demanded by various size stokers may be met by moderate chain-sprocket ratios. The gear-box driving sprocket is mounted on and keyed to a flanged sleeve at the end of the speed shaft. It drives through a shearing-pin flange *A* keyed to the shaft. A small-diameter shearing pin passing through both flange and sleeve, eliminates any damage from overloading.

Lincoln Gas-Engine-Driven Welder

A SELF-CONTAINED lightweight, readily-portable arc welder which is specially adapted to welding in structural work, pipe line construction and similar work, has recently been added to the line of welding equipment put out by the Lincoln Electric Company, Cleveland, Ohio. The new welder is known as F-1960 model.

The new unit has a rating of 200 amperes with a current range for welding of from 50 to 300 amperes, and operates at a speed of 1,500 r.p.m. Motive power is provided by a four-cylinder Continental Red Seal Engine, type H. 9.

The welding generator and engine



Welder with four-cylinder motor on structural steel frame

are mounted on a structural base welded into a solid piece. This welded base provides a maximum rigidity with a minimum weight. The whole unit weighs only 1,580 lb., being 76 in. long by 25 in. wide.

The complete magnetic circuit of the generator is of laminated steel structure. This, it is claimed, tends to increase the stability of the arc, which is particularly desirable when welding must be done in a vertical plane and frequently overhead.

A steel switchboard is provided in place of the usual plate or composition board, thus still further reducing the possibility of damage or interruption in the field.

This unit supplements the heavy-duty engine-driven equipment brought out some time ago by this company.

New Chart Hub for Recording Instruments

THE new push-button chart hub illustrated is a refinement recently applied to the line of recording instruments put out by the Foxboro Company, Inc., Foxboro, Mass. A slight push of the tension head snaps it into position, where it grips the chart securely in place. Simply twisting the head to left or right turns the chart to the correct time adjustment, removing the chart holder being unnecessary.

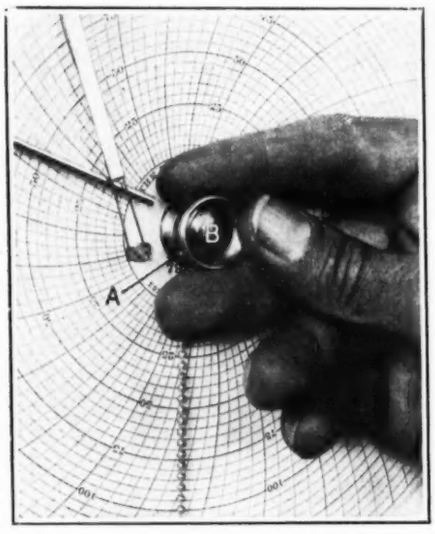


Chart hub with push-button release

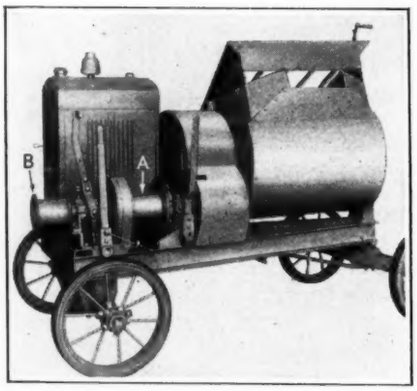
The ease with which the hub can be detached is an important factor. With the holder *A* between the first and second fingers, the operator has simply to press the button *B* and the chart is released.

A Plaster Mixer with a Hoist

INSTALLATION of a hoist on its plaster mixer, "The Mechanical Hoeman," illustrated, has been announced by Marsh-Capron Manufacturing Company, 11 South La Salle St., Chicago, Ill.

The hoist *A* is mounted on the countershaft of the mixer and can be operated while mixing or independently. It is provided with an automatic brake which holds the load when the clutch is disengaged. The large winch head *B* projects in the front of the machine, making it adaptable for the operation of elevators or other hoisting work. The hoist is also provided with a safety ratchet and with automatic lubrication.

Another improvement recently announced on this plaster mixer is a new stuffing box on the hoe shaft. A semi-metallic packing is used in an outside stuffing box mounted in a cast head in the drumhead casting. The packing can be changed at any time without dismantling any other part of the machine, and the packing glands can be tightened with the machine in operation. The machine is provided in two styles of mounting—a four-wheel rubber-tired trailer, with telescoping steel hauling hitch where a high degree of portability is desirable, or on a truck with four steel wheels.



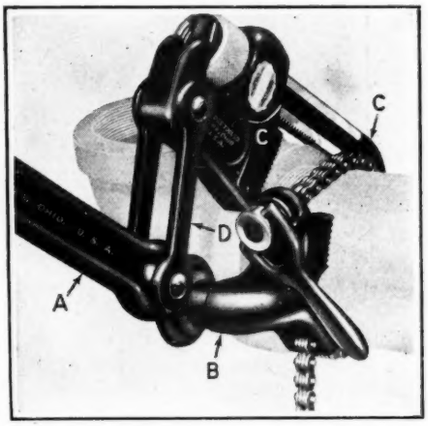
Mixer fitted with hoist and winch head

The unit is provided with a mixing hoe formed of steel bars especially shaped to give rapid, thorough mixing and complete scraping of the barrel at every revolution. Discharge is effected by rotating the drum, the discharge spout being part of the drum itself and so shaped as to confine the batch to a narrow stream, permitting discharge directly into wheelbarrows.

The completely inclosed two-cylinder hopper-cooled LeRoi or Novo engine is continued as standard equipment, with electric motor drive optional.

"Ridgid" Pipe Wrench with Compound Leverage

WITH a view to reducing the manual labor required to tighten up pipe joints, the Ridge Tool Company, Elyria, Ohio, has brought out the "Ridgid" pipe wrench illustrated. As will be seen, the wrench has a compound leverage, which it is claimed gives it fourteen times the leverage of a standard 48-in. wrench, although the handle is no longer than that of a 36-in. wrench. Just how this leverage is accomplished will be readily understood from a study of the illustration. The end of the lever or handle *A* is hinged to a toothed trunnion *B*, which is rigidly clamped to the pipe by means of a chain, while the adjustable jaws *C* of the wrench are on the fitting to be tightened. As the jaws *C* are connected to the lever *A* by means of a link *D*, a pull exerted on the lever *A* will tend to turn the pipe and fitting in opposite directions, or to screw them tighter together. To unscrew a joint, the wrench is simply reversed. As the link *D* is connected to the lever close to the trunnion *B*, a powerful leverage is obtained. Also, since the action of the jaws *C* and the trunnion *B* are counterbalanced, or opposed, there is little strain exerted on the pipe line, and joints already tightened are not disturbed. The wrench is being made in sizes up to 6-inch.



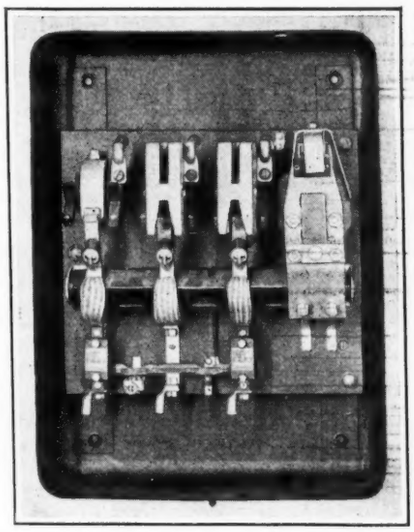
Wrench in position for tightening joint

New Switch Throws Motors Across the Line

A NEW magnetic switch, suitable for throwing squirrel-cage motors directly across the line or for use as a primary switch for a wound-rotor motor the secondary of which is handled by a drum controller, has been introduced by the General Electric Company. This switch consists of a triple-pole, restricted-blowout type, magnetically operated contactor with normally open interlock, and two hand-reset, temperature overload relays, all mounted on a molded base and inclosed in a drawn-shell, steel inclosing case. It is designed for use on standard voltages and frequencies, and maximum horsepower ratings.

Overload protection is provided by two temperature overload relays which, upon an overload, open the contactor. The operation of either or both relays will trip the contact mechanism so that all phases of the motor are properly protected.

The switch is ordinarily operated by means of a "start-stop" push-button station of the momentary-contact type and with an extra pole on the magnetic contactor to provide



Contactor switch equipped with overload relays

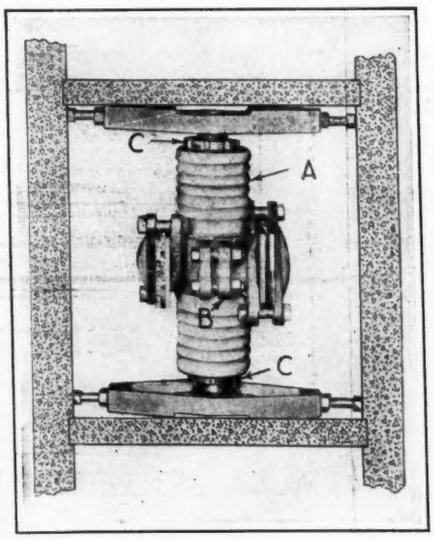
an electrical interlock for the holding circuit. If such a push-button station is used and the voltage fails, the contactor will open and will not close automatically on return of voltage, but the "start" button must be pressed to restart the motor. If desired, the switch may be controlled from a number of places by installing a suitable number of push-button stations.

When the switch is used to handle the primary circuit of a wound-rotor motor in connection with a secondary drum switch, the push-button station is not required, as provision is made in the switch for closing the contactor coil circuit as the switch handle is turned to the first point, and to open it in returning the handle to the "off" position. Such a combination provides under-voltage protection.

The new switch may also be operated by means of any master switch of the single-pole, single-throw type, such as knife switches, pressure governors, pressure switches, float switches, etc.

Connection Support Easily Installed

AN EXTRA strong bus or connection support which requires no setting of bolts in concrete or drilling



Connection support expanded in place

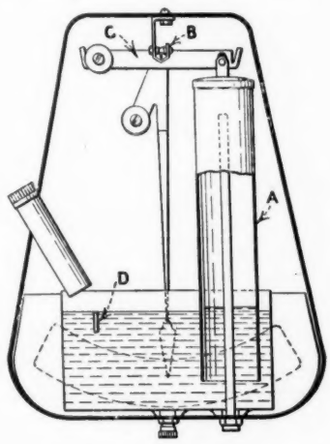
for expansion bolts, but is simply mechanically expanded against the sides, top and bottom of the compartment or enclosure in which it is installed, has been introduced by the General Electric Company, Schenectady, N. Y. The support consists of an ordinary cylindrical bushing *A* with expansion elements at either end and a connection clamp *B* over the middle.

The expansion element is a pipe nipple with a stationary flange and a movable locknut. Vertical expansion is accomplished by unscrewing the locknut *C* against the bushing until the assembled unit bears rigidly against the top and bottom shelves. The stationary flange is provided with a screw and locknut at either end, by means of which it is expanded horizontally and firmly held against the sides of the inclosure. b

Ellison Single-Pointer Draft Gage

THE improved single-pointer dial-type draft gage illustrated has recently been added to the line put out by Lewis M. Ellison, 214 W. Kinzie St., Chicago, Ill.

The new instrument embodies



Cross-Section of Gage

many of the important features of the multi-pointer gage announced by this company about a year ago. Referring to Fig. 2, the operating bell *A* is unusually large, being 2¼ in. in diameter, with 2-in. travel for the low ranges, giving a displacement of 8 cubic inches. The fulcrum knife edges *B* on the counterweighted beam *C*, on which the bell and pointer are suspended, are of steel, casehardened and honed. The pointer is of the tapered-channel type, minimizing vibration.

The liquid pan is of large area in relation to the bell displacement. A filler is conveniently placed in the side of the case, and the level of the liquid can be readily observed through it. A ¾-in. bar *D* is placed across the pan so that the top is the normal level and the bottom edge the low level.

The scale is of white celluloid, 10 in. long and of good visibility, with black graduations and figures 9/16 in. high. The range of the instrument is up to 5 in. minus and 6 in. plus. The casing is of cast aluminum, dust-proof, with removable back for inspection. The dimensions of the gage are 4 in. deep, 13 in. wide and 17¾ in. high.

Performance Records of

Oil-Engine Locomotives*

By Herman Lemp
Consulting Engineer, Ingersoll-Rand Company, New York City

FOR years the advantages and disadvantages of the internal-combustion-engine locomotive have been brought to the technical forum, particularly in comparison with steam and electric locomotives. The high fuel economy, the ease of operation and the independence as a unit of the oil-engine locomotive has been conceded from the beginning. The items of importance to be determined by actual service were the cost of maintenance and all-round availability for service.

The gas-electric equipments, as built by the General Electric Company before the War, have shown remarkably low maintenance charges, and it was expected and hoped that the oil locomotive would show equal results. Experience with the gas-electric car showed that maintenance was low when more than one unit was in use by one railroad, but less so when only one unit was in service. The explanation was that twenty years ago to discover and remedy defects in an internal-combustion engine required that the men in the steam maintenance department be educated and familiarized with the operation of internal-combustion engines, and when a number of rail cars were owned by one railroad, usually a special department was created to be responsible for the availability of the equipment.

Responsibility for Maintenance

With the oil-electric locomotives in commercial use in this country for more than three years, a somewhat similar experience is obtained, with this exception, however, that when even one unit is in service, someone in the organization has been made responsible for its maintenance. The general use of automobiles, motor boat and stationary engines has greatly assisted in training the modern mechanic to a better understanding of the internal-combustion engine, and his recent education pertains more to the difference betwen an engine with electric ignition using gasoline as a fuel and one using auto-ignition by high compression with a heavy oil injected in atomized form by pressure.

It is to be expected that a light high-speed Diesel engine on mobile equipments has problems of its own to eliminate, and taking both these natural obstacles under consideration, the practical experience of the last three years has been encouraging.

*Abstract of paper read before the Metropolitan Section, American Society of Mechanical Engineers, New York, April 17.

The oil-electric locomotive is the only oil locomotive on standard-gage railroad tracks that has any service records to offer in this country. Abroad, a 1,000-hp. oil locomotive with mechanical transmission has been in operation on the Russian railways since March, 1927, and a duplicate is expected to be run on the Boston & Maine's tracks some time next July.

The fuel consumption expressed in pounds per thousand ton-miles evidently depends upon profile of road, load factor, speed of train, etc., and unless these conditions are known and duplicated, they cannot serve as a true comparison.

For instance, a 100-ton oil-electric locomotive pulling a freight train of 377 gross ton weight, at an average speed of 18.7 miles per hour from Erie, Pa., to Greenville, N. J., consumed 2,449 lb. of fuel, or 17.1 lb. per 1,000 ton-miles. A similar locomotive geared for passenger service, pulling four standard coaches of 280.5 gross tons from Hornell, N. Y., to Meadville, Pa., at an average speed of 37.7 miles per hour, used 980 lb. of fuel, or 18.9 lb. per 1,000 ton-miles; while a 60-ton oil unit pulling freight of a gross weight of 4,125 tons in New York at the rate of 2.8 miles per hour, with 43.8 lb. of fuel, covered 1,000 ton-miles with only 10.6 lb. of fuel.

A 100-ton oil-electric locomotive in the lumber district in California did 48,000 ton-miles in 19 hours with 1,312 lb. of fuel, or 27.3 lb. per 1,000 ton-miles. A modern steam locomotive with superheater also using fuel oil, working on the same job in the same location did 37,000 ton-miles in 26 hours, using 10,000 lb. of fuel or 270 lb. per 1,000 ton-miles—nearly ten times as much.

In this country there are some 10-ton oil locomotives built for contracting work with mechanical transmission and stated to give satisfactory performance, but they are not included in this paper since they are not built for standard railroad tracks.

A 100-ton oil-electric locomotive

The oil-electric locomotives in operation in this country both in railroads and industrial yards are used exclusively for switching purposes. Passenger and main-line freight service is about to be inaugurated by the New York Central Railroad on the Putnam Division. The performance of oil-electric rail cars would indicate that the maintenance of main-line equipment will not be any more severe than that of switching engines. In Europe, particularly in Russia and Sweden, the main-line operation is considered satisfactory.

There have been installed in the last three years, up to Jan. 1, 1928, fourteen 60-ton and five 100-ton oil-electric loco-

motives, jointly built by the American Locomotive, General Electric and Ingersoll-Rand companies, the 100-ton being provided with two 300-hp. generating units. Two additional 60-ton and two 100-ton locomotives are about to be delivered. In addition there is one 60-ton oil-electric locomotive built by the McIntosh & Seymour Coporation.

Attention is drawn to the report of the Committee on Diesel Locomotives of the International Railway Fuel Association of Chicago, May 10-13, 1927, in which answers to a questionnaire sent to the various railroads in America using oil-electric locomotives were appended. The replies received gave comparisons between steam and oil-electric operation and were analyzed by A. Lipetz in his very complete paper, "The Present Status of the Oil-Engine Locomotive," read before the American Railroad Association in June, 1927. From it he concluded that a 30 per cent saving in switching operating expense could be made over steam operation, for main-line operation and a 50 per cent saving found in connection with Diesel rail cars.

Another questionnaire has recently been sent out by the author to the various railroads and industrials who have bought these equipments and the returns analyzed to our best ability. From them we learn the following:

On 60-ton locomotives the average availability, based on 24-hour service for 300 days per annum for 1927, has been 91.5 per cent, the lowest of which is 72 and the highest 99 per cent. In this connection it is interesting to note that one of 81.5 per cent applies to the first locomotive installed on a certain railroad and later repeat orders brought it up to 94 per cent, showing that the higher percentage is really due to better familiarity with equipment. The 100-ton equipments show a similiar increase in availability, but have not as yet reached the average of 91.5.

The service these locomotives perform varies considerably. Some are on light eight-hour shift schedules with a load factor less than 10 per cent, and their chief advantage lies in giving a smokeless and noiseless operation.

To form an idea of the practical every-day work performed by oil-electric switching locomotives in 1927, note the following done by two only, picked at random, one single shift in New York, the other three shifts in Chicago.

	New York	Chicago
Kilowatt hours generated	47,000	149,200
Fuel consumed, gal.	11,500	26,600
Ton-miles delivered	671,000	3,730,000

In Chicago three 60-ton oil-electric locomotives of 300 hp. each have replaced six steam locomotives of 600 hp. to do the same work. They are employed 24 hours a day for six days with three crews per locomotive.

With regard to expense of maintenance we find that 10.1c. per locomotive-mile will apply even under present conditions and shows indications of improving.

Session on Material Handling Arouses Interest

MORE than two hundred engineers, equipment manufacturers and industrialists joined enthusiastically in the first national meeting of the Materials Handling Division, American Society of Mechanical Engineers, on April 23 and 24, in Philadelphia. Coal handling, ash disposal, bulk handling, interior handling and freight handling by railroad and steamship, were among the topics discussed. The evening session on April 24 was a joint meeting with the National Coal Association and the American Institute of Mining and Metallurgical Engineers, at which mechanization of material handling in coal mines was discussed. An informal dinner was held on the evening of April 23, at which the relation of purchasing to material handling was discussed by C. D. Young, general purchasing agent, Pennsylvania Railroad; and the necessity of increased labor saving to the success of our export trade was pointed out by E. J. Mehren, vice-president, McGraw-Hill Publishing Company, Inc.

Papers of particular interest to power engineers included: "Modern Methods of Handling Coal, Ore and Other Bulk Materials," by Arthur F. Case, Wellman, Seaver, Morgan Company; "Methods and Equipment for Fuel Handling and Ash Disposal," by James R. McCausland, Philadelphia Electric Company; and "Handling of Ash by a Hydraulic System," by Arthur M. Quinn, Allen-Sherman-Hoff Company. In his paper on "Pneumatic Handling of Materials," Harry S. Parks, Holly Pneumatic Systems, Inc., described the application of a pneumatic handling system to the cleaning of boiler firing floors and other parts of the Delaware Station, Philadelphia Electric Company.

Coal and Ash Handling Costs at Philadelphia Electric Company's Plants

The paper by Mr. McCausland gave some interesting data concerning operating costs of fuel and ash handling at the Richmond, Delaware and Chester stations of his company. In each case the bulk of the coal is delivered to the plant in barges and is elevated by grab-buckets to towers. In the case of Chester the towers are integral with the building and the coal passes from the receiving hopper to double-roll crushers, thence to cable cars which distribute it to the bunkers.

At Delaware and Richmond the coal is distributed from the receiving hoppers on a short apron feeder, from which it feeds over a rotating grizzly, the latter equipped with multiple disks set for 1¼-in. screenings. The "fines" are diverted to a hopper over the main inclined belt and the "overs" discharge onto a picking table, then pass through a crusher to the inclined belts which are carried on anti-friction rollers. These belts discharge to transfer belts and thence to bunker belts, where the coal is diverted to the desired bunker. Each belt system was designed to carry 365 net tons per hour, but is capable of carrying 410 tons.

At all the stations except Schuylkill and the old part of Chester, the ash hoppers under the boilers are equipped with piston-type air operated, double-acting ash gates. The ashes are drawn into dump cars and hauled by storage-battery locomotives to the pit or skip hoist. At Richmond and Chester there is a pit holding about three days' run, and at Delaware and Schuylkill a skip hoist is provided with overhead tanks of approximately two days' run. In connection with the ashpits locomotive cranes are used to transfer the ashes into railroad cars or on lighters.

Experience has shown that the pit-and-crane combination is the most desirable in that the investment cost is lower than that required for the skip-hoist construction, the maintenance cost is lower, and the operation as a whole is more flexible. This is not meant to imply that the skip hoist is an expensive piece of apparatus to operate, but it takes into consideration the extra investment required for special structural treatment to make the tanks and the building housing the skip hoist harmonize with the architectural features as was necessary at Delaware Station.

[An abstract of Mr. Quinn's paper will appear lated.—Editor.]

COAL-HANDLING DATA

	Richmond	Delaware	Chester
Coal towers	2	2	2
Height of boom, ft.	93	87	165
Operating cycle			
Complete cycle, sec.	18.7	16.4	33.6
Average rate, net tons per hour	269	283	170
Buckets	Two 1½-ton grab (cable)	Two 1½-ton grab (chain and cable)	Two 1½-ton grab (chain and cable)
Cable life (avg.) long tons	180,000	200,000	80,000
Crushers	Two double-roll	Two double-roll	Two double-roll
Main belts	Two 36-in., 8-ply 968-ft. long	Two 30-in., 6 ply 750-ft. long	Cable road having a ¾-in., 6x9 cable approx. 1,400 ft. long.
Transverse belts	Two 36-in., 251-ft.	None	
Bunker belts	Two 36-in., 613 ft.	Four 30-in., 382 ft.	
General Costs:			
Power per ton, mills	6.5	4	5.3
Labor per ton, cents	4	4	3.5
Maintenance per ton, cents	2.5	3	3

Locomotive cranes on system, 30-ton cranes, 60-ft. booms.
Operating cost, labor and maintenance, $2.75 per hour.
Cost of handling coal or from stock, including labor and maintenance of machinery 9 to 14 cents per ton.

Tests on Armored Cable Show Present Designs Satisfactory

THE manufacturers of armored cable have approved in principle the recommendations of the report of Underwriters' Laboratories made as a result of research undertaken at their instance and request, pursued for upward of a year. The object of this research was to determine the various electrical and physical properties of armored cables in relation to the use of the product under the conditions of the National Electrical Code.

The detailed results of tests described in the report covering the physical properties of resistance to tension and crushing loads give conclusive evidence of acceptable values in these properties of the product of the industry as a whole. These results seem to dispose of the questions raised in the minds of inspection authorities and of contractors covering the new standard for thickness of strip of 0.025 instead of the value of 0.034 in. in effect prior to 1925.

Tests Made on Samples

In laboratory tests many samples representative of all makes and designs of armored cable were subjected to electrical burnout and overload current tests to determine the characteristic performance when abnormal conditions exceeding those contemplated in the National Electrical Code rules were imposed. The report shows that cable made of 0.025 strip does not convey fire to the outside when burnouts of conductors take place with the conductors loaded up to 100 per cent in excess of National Electrical Code standard fusing for the circuits involved.

Determinations of resistance and conductivity developed the interesting point that overheating, when carrying grounding currents, would not occur with loads greatly in excess of those appropriate for the fusing of the circuits, and further, that the actual conductivity of the metal strip of armor varied according to the attitude of the armor as installed; at bends or when the cable was in other than the lying-straight position, the resistance dropped to values much less than obtained when specimens were lying straight. This phenomenon is due to the contacts made by the edges of the strip in the convolutions which form the armor with the surface of the adjoining strip. These contacts are better electrically on account of the pressure produced by the curved attitude of the armoring.

It was shown that it will be feasible to specify and obtain such a maximum value for resistance of armor when in the lying-straight position as to produce no dangerous rise in temperature in the metal when it is called upon to carry grounding currents much in excess of those for which the circuit wires are properly fused.

All manufacturers in the industry are now co-operating with the staff of the laboratories relative to the installation of equipment and test methods to control this factor on the entire output.

The report thoroughly disposes of questions that have been raised concerning the resistance of connections at outlet fittings. All usual makes and types of terminal fittings with many of the standard makes and types of outlet boxes were tested with various combinations and sizes of standard armored cable. In general, the data of the report show that the resistance across an outlet including two fittings is no greater than the resistance of a run of six inches of the cable itself.

These results were the considerations leading the Committee on Wiring Methods (Article 5 of the National Electrical Code) to take no action on the proposed recommendation that the conductivity and reliability of connections of armored cable for protective grounding purposes be supplemented by a special grounding conductor.

Inherent Regulation, a New Law in the Control Art

IN THE *Zeitschrift des Vereines Deutscher Ingenieure* for Feb. 11 and 18, 1928, Th. Stein, of Berlin, points out that in the past the solution of a regulation problem frequently included all the factors that influence the regulating or governing process. This led to unduly complicated construction. It has since been learned that the task is much simpler than would be inferred from earlier theory. For example, the restoring mechanism formerly considered indispensable in regulators employing auxiliary power may often be omitted, not only simplifying the mechanism, but resulting in steadier operation of the governor, or, in other words, a reduction of hunting.

Experience indicates that regulators that operate satisfactorily under certain conditions may fail to operate under somewhat different conditions.

New Steam Plants

The study and design of newer types of steam plants, in which automatic operation is being introduced more and more, has brought out the need for harmonizing the theory of regulation with actual plant experience, so as to be able to determine beforehand whether a contemplated design will serve the purpose and how it may be improved.

In many processes there is under certain conditions a tendency to inherent regulation; that is, any departure from equilibrium conditions nearly always results in counter action that tends to check the change. For example, if an increased amount of steam is drawn from a piping system, the pressure in the network will fall, and, accordingly, the steam flow from the network to various steam-using equipment will be decreased. If the quantity withdrawn is not too great, the pressure drop may come to a standstill without the action of a regulator. In the same way a steam turbine driving an electric generator connected to a fixed load tends to be self-regulating. If the steam supply increases the speed will rise, and in the absence of special adjustments, the power delivered to the load will increase with the generator speed.

Use is often made of this inherent regulation when the change of conditions is of no importance. Many plants might thus operate without regulation. Governors or other types of regulators, where provided, serve merely to limit the change of one or another condition, such as speed or pressure or water level, which might otherwise vary beyond safe or convenient limits.

The author develops a mathematical theory of regulation and illustrates its application to a number of practical cases.

He discusses the determination of governing characteristics and stability for various situations.

This extended discussion should prove exceptionally valuable to those who are concerned with the design of automatic control devices, including speed governors, all sorts of combustion-control equipment, pressure-reducing valves, water-level controls, and the like. The treatment is mathematical and somewhat involved, but should prove illuminating for those who are engaged in work of this sort.

IN A RECENT REPORT of the National Electric Light Association Hydraulic Power Committee, the statement is made that tests and metering enabled the Southern California Edison Company to improve the efficiency of its hydro-electric plants in 1926, so that the output was increased some 15,000,000 kw.-hr. over the 1925 production, with the same amount of water and head. This is a gain of about 1.5 per cent, which has a sales value of about $70,000 and is 20 per cent more than the whole cost of the metering equipment.

Power Conversion Solution

C	O	A	L
C	O	A	T
B	O	A	T
B	E	A	T
H	E	A	T

RECENT PUBLICATIONS

ANALYSIS OF ARKANSAS COALS. Technical Paper No. 416, United States Bureau of Mines. Sold by Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 26 pages. Price, 5 cents.

THIS pamphlet describes the coals of the Arkansas fields, semi-anthracite, bituminous and lignite. The occurrence and characteristics are briefly given and an estimate of the reserves is made. The main part of the pamphlet gives proximate analyses, ultimate analyses, calorific values and softening temperature of the ash for all the coals of any importance that are mined in Arkansas. It should prove of great value to consumers, present or prospective, of fuels from this region.

AMERICAN STANDARD MATHEMATICAL SYMBOLS. Prepared by Sectional Committee on Scientific and Engineering Symbols and Abbreviations. Approved by American Engineering Standards Committee, January, 1928. Published by the American Engineering Standards Committee. Leaflet, 8 pages. Price, 30 cents.

THIS leaflet, giving the approved mathematical symbols, is to be followed by other symbol standards covering mechanics, structural engineering and testing materials, hydraulics, heat and thermodynamics, photometry and illumination, aëronautics, electrotechnics, navigation and topography. Another will cover abbreviations for scientific and engineering terms.

DIESEL AND OIL ENGINEERING HANDBOOK. By Julius Rosbloom. Published by The Industrial Institute, Inc., Brooklyn, N. Y. Cloth; 5x7¼ in.; 596 pages; numerous tables and illustrations. Price, $5.

WHEN reviewing a book, it is the practice of the editor to glance over the preface to find out the author's purpose. The author of this volume states that the language is plain and the material carefully selected. In this the reviewer cannot agree, as the volume is undoubtedly one of the most poorly written engineering handbooks, from a sentence-construction point of view, that has been so far published. The author concededly is familiar with oil engines, but his method of thinking is so involved and the grammatical construction of the statements so confusing that whatever of value he has to say will escape the reader. Even though the reviewer is familiar with oil engines, he is not willing to subscribe to the statement that "in two-stroke-cycle engines valves are entirely eliminated." Nor to the one on page 26 to the effect that the lubricating oil consumption of the Diesel high-speed engine is at the rate of 1 gal. per 50 to 350 horsepower-hours. Nor will the mass of engineers familiar with oil engines agree that the low-compression engine is equal to the high-compression engine in fuel economy. We read under the subheading of Double-Acting Principle that "The main part of the engine will not be influenced by any outside force, excepting such essential in maintenance, therefore causing reliability in operation, heat and internal strains throughout the unit." This sentence is enough to make the reader lose his confidence in the author's engineering ability. In fact, the readable portions of this book are those sections supplied by the Diesel manufacturers or lifted from prior publications. It is unfortunate that the author did not realize his deficiencies, and the publishers are equally guilty, for, properly edited, the volume would have been of value.

AMERICAN UNIVERSITIES AND COLLEGES. Edited by David Allan Robertson. (The American Council on Education.) New York and London. Charles Scribner's Sons. Cloth; 6x9 in.; 884 pages. Price, $2.50.

THE character, scope and organization of higher education in the United States is reviewed in Part I of this volume. Part II presents condensed information regarding each of the universities and colleges on the accredited list of the American Council of Education. Supplementary information regarding thirteen classes of professional and fifteen classes of graduate schools is given in Part I. For some unexplained reason, engineering schools have far less space in proportion to their number than the other schools. Thus 130 engineering schools are given less than three pages, consisting mostly of names of schools by states, while 25 schools of economics are given eleven pages, with a list of professors, their degrees (by institutions), the subjects they teach, and in some instances other information as well.

The great variety of college degrees granted in America is illustrated by a list of the corresponding abbreviations used in the book, which has about 170 entries, of which 40 are courses in engineering, not including B.S. in Geodesy and Surveying or San.D. for Doctor of Sanitation. Another item of interest gleaned from the book is the hospitality shown to students from abroad by our schools and colleges. Figures for the year 1923-24 compiled by the Institute of International Education for only 400 institutions showed 6,988 foreign students. Deducting 1,332 as "unclassified," it appears that over one-fifth (1,238) of the remaining 5,656 were students in engineering, compared with 1,966 students in liberal arts, 510 in medicine and 389 in commerce. The total number of students from over a hundred foreign countries is given for the five college years ending with 1925-26. The five countries highest in number of foreign students in American colleges for the year 1925-26 were: China, 1,317; Canada, 733; Japan, 685 each; Poland, 571; Russia, 515. Totals for each year are not given.

It is a great pity that after bringing together so many figures on a variety of subjects as this volume contains, practically no summaries are included. Another sad lack of the volume is an introduction in the nature of a general summary. Valuable as the book is as a compilation, it is chiefly that and nothing more. Certainly a book sponsored by educators should supply digests of the data it contains instead of compelling thousands of users to make the digests separately or do without.

INDUCTION MOTOR PRACTICE. By A. M. Dudley. Published by the McGraw Hill Book Company, Inc., 370 Seventh Ave., New York City, and London, England, 1928. Cloth; 6x9 in.; 236 pages; illustrated. Price, $2.50.

THIS book is a companion to the author's earlier book, "Connecting Induction Motors," in which winding was treated of chiefly. In the latest book the characteristics, such as the rotating magnetic field, speed-torque relations, mechanical considerations, and the complete performance of the motor figured from the circle diagram, are given consideration.

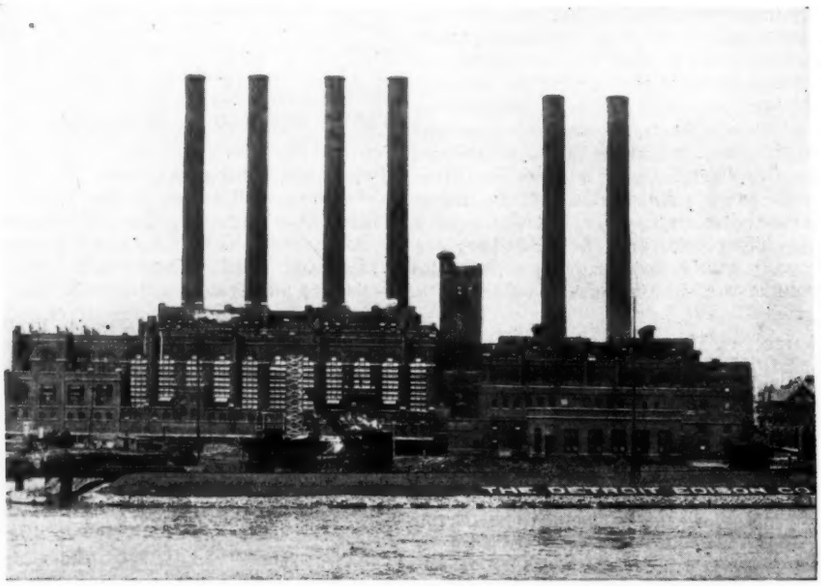
The subject is divided into eleven chapters: Fundamental and elementary considerations; the rotating magnetic field; mechanical parts and assembly; stator windings; squirrel-cage and wound-rotor types; electrical and operating characteristics; speed-torque curves; control; mechanical considerations; the circle diagram; and the question box.

A feature of the work that will appeal to the student of induction motors is the careful and detailed explanation given of different features of motor operation. An example of this is in the discussion of the circle diagram, which has been explained so that those with a knowledge of the simple elements of arithmetic and plane geometry only, can construct such a diagram and understand its use. The last chapter of the book, comprising 76 pages, gives the answer to a large number of practical questions on induction motor operation. These questions and answers have appeared in the *Electric Journal* Question Box over a period of years and have now been brought together for ready reference.

The treatment through this volume is comparable with the simple language used in its predecessor. Involved mathematical formulas have been avoided so that the book is in general readily understood by the practical electrician. It is unique in that it brings the experiences of a designing engineer to operating men and students in such a way that they can be applied in the solution of practical problems, making it a valuable companion to the author's previous book dealing with induction motor winding.

NEWS OF THE FIELD

The editors will welcome the co-operation of readers in reporting interesting happenings, personal or otherwise



The new plant, Delray No. 3, is being built between these plants and the river

Detroit Edison Company Selects Stokers for New Plant at Delray

Lack of ash disposal facilities influenced decision to use stokers. Experience with pulverized coal at Trenton Channel satisfactory

IN THE May issue of the *Synchroscope*, published by the Detroit Edison Company, J. W. Parker, chief engineer of the company, announces the choice of stokers for the new plant to be known as Delray No. 3, and explains why. The wide interest displayed in the decision, which has been pending for some months, and the seemingly secondary reason for it, justify the verbatim quotation of Mr. Parker's statement.

The Detroit Edison Company has just decided to install underfeed stokers for the first six boiler units of their new plant, now in course of construction, which is to be known as Delray Power House No. 3. Inasmuch as this company's Trenton Channel plant, which immediately preceded this in construction, is equipped for pulverized fuel burning, the choice of stokers for Delray No. 3 might be misinterpreted as indicating that in the opinion of the company's engineers the stoker method of firing had inherent advantages over the pulverized-fuel method. Any such inference would be misleading in the extreme.

It is pertinent to explain that until Trenton Channel was built, it had been the Detroit Edison Company's long established practice in all its power plants, at Delray, Connors Creek and most recently at Marysvile, to employ an underfeed type of stoker well suited to the character of the best coal ordinarily available; a comparatively low-fusing very high volatile bituminous coal from West Virginia and eastern Kentucky. Long experience with stokers had developed the company's stoker practice to a satisfactorily high standard at the time the Trenton Channel plant was designed. The use of pulverized fuel at Trenton was therefore a new departure in the company's practice. The factor that conclusively determined that departure was the belief, later amply borne out by the result, that with pulverized fuel the plant would very easily adapt itself to minor variations in character of coal without impairment of capacity and with a minimum impairment of efficiency.

It was felt highly desirable to have at least one such plant in the system in order to facilitate classifying the incoming coal and, if it should ever become necessary, to permit favoring the older plants at Delray and Connors Creek in the allocation of the received fuel. The southern site Trenton Channel and its large trackage for receipt of coal, made it particularly suitable as the pulverized coal plant in this set-up. Its projected large share in total output (41 per cent in 1927) would necessarily make it an important factor in the problem of fuel supply.

Trenton Channel with the last of its complement of six 50,000-kw. turbines now being erected, has justified the decision made at the time its design was fixed. The investment per kilowatt installed is moderate, and its operating performance has never fallen below the estimate of efficiency. For more than a year and a half it has consistently bettered that estimate, and there is a reasonable expectation of further improvement.

Problems incidental to the method of fuel burning have been satisfactorily met; for instance, the problem of substantial reduction of the fine ash carried away by the furnace gases. The Cottrell precipitators with which all the boilers are now equipped seem to be entirely practicable pieces of power-plant equipment and are catching large quantities of dust which for the time being is sluiced on to nearby marshy ground.

At Delray the new plant will be handled by the same organization that has superintendence of the two older power houses Nos. 1 and 2. The management of stokers for high efficiency will be no novelty for that group of men. Estimates of performance and of required investment for the two types of plant (stoker and pulverized fuel) indicate total costs for the Delray location so nearly alike as to suggest the question whether or not the difference is of the same order as the possible errors of estimate.

The final decision to install stokers in the first section of the plant was determined by a consideration ordinarily too insignificant to become a controlling factor. Up to the present time no permanently satisfactory way has been found for disposing of the fine ash produced by pulverized-fuel furnaces, after it has been caught. At Trenton Channel there are still marshes to be filled in, but there are no longer any such hollows near Delray. Conversely, the sale of stoker cinders from the Delray plant in a local market which it has never been possible to satisfy, will earn a credit of something more than 6½ cents per ton of coal burned. These well burned cin-

ders are used as aggregate for concrete roof and floor slabs, as the body of so-called cinder blocks used in building construction, and in other ways which constitute a demand for cinders all the year round. But nobody wants the fine residuum from pulverized coal fires.

The design of the new Delray boiler furnaces can be easily adapted to pulverized fuel, and the plant would accommodate the necessary equipment, but until this particular commercial problem of ash-dust disposal is solved, the Detroit Edison Company prefers, and will continue, the use of stokers at the Delray plants.

N. Y. Edison Co. Installs New Coaling System

A new coal hoisting system that unloads coal directly from ocean-going vessels into the power-generating stations of The New York Edison Company, located on the East River at 38th to 40th Streets, has just been put into operation with the unloading of the Pocahontas Steamship Company collier "Bristol," from Norfolk.

The effect of the new coal hoisting system, an official of The New York Edison Company said, is to broaden the company's coal market, so that now coal may be obtained either by ocean-going colliers or by rail. Also, the new system can unload coal from moored colliers into barges for transport to the other power generating plants of the company, as required.

In the new system the bucket hoist is only 60 ft. The clamshell buckets place the coal on belt conveyors, one of which is 395 ft. long, for the remaining elevation of 100 or more feet to the bunkers. These long conveyors reach out to 30-ft. deep water, where ocean-going vessels can be moored. Two steel towers for hoisting the grab buckets travel on rails, permitting the buckets to be dropped into the various hatches without moving the vessel. The two buckets have a capacity of 350 tons an hour each. The "Bristol," the first collier to be unloaded by the new system, carried 6,600 tons.

Largest Automatic Hydro-Electric in Canada Goes into Operation

Plant containing one 12,500-hp. unit operating under maximum head of 154 ft., will be started and stopped from another plant, twelve miles away, by closing transmission line oil switch

THE British Columbia Electric Railway Company has completed construction of a 12,500-hp. hydro-electric plant at Alouette in British Columbia. While comparatively small in the horsepower developed and costing $2,500,000, the plant is nevertheless interesting since it is automatically controlled from the Stave Falls plant of the company situated approximately twelve miles away.

Automatic switching equipment has been used extensively in the United States with a marked degree of success for a number of years past, but the Alouette generating station is the first major plant to be completed with complete automatic control in Canada. The plant is on the shores of Stave Lake, and the two stations are connected by a transmission line. The water flowing through the Alouette plant is used again at the Stave Falls power house, and when the company erects its proposed power house at Ruskin, the water will be used a third time for power development.

The equipment of the station consists of one vertical-shaft alternator rated at 10,000 kva. 7,500-volt three-phase 60 cycle and is driven by a 12,500-hp. Francis type turbine which operates under a static head varying from a normal low flow of 124 ft. to normal high flow of 154 ft. The turbine and generator were supplied by the English Electric Company, who sent an engineer from England to supervise the erection of the machinery.

Excitation of the alternator will normally be supplied by a direct-connected direct-current generator, but in case of emergency provision has been made by a spare waterwheel driven exciter.

The power is generated at 6,825 to 7,500 volts, which is stepped up to 60,000 to 63,000 volts and is transmitted to the Stave Falls plant, at which point it is connected with the lower mainline of the system. To start the Alouette plant, the line at Stave Falls will be energized and the plant will be shut down by opening the same circuit breaker. Provision is also made so that Alouette station can be manually operated in case of an emergency when there would be no voltage available at Stave Falls for opening or closing the breaker.

The automatic equipment of this plant is possibly worthy of particular mention. The Alouette plant starts to operate whenever the connecting transmission line is energized. The penstock valve is opened by means of a motor put in operation automatically from Stave Falls. When the pressure is built up, the brakes on the generator are released and the turbine gates start to open, thus causing the machinery to begin functioning. As the generator develops speed, the exciter's voltage builds up and is applied to the generator field. It is essential that the design of the turbine and governor be such that the wheel is accelerating slowly as it approaches synchronous speed. The automatic synchronizing equipment takes control of the speed of the machine and at the proper time functions to close the oil circuit breaker, which connects the generator to the energized line. The machine will then take load in accordance with the governor setting and the system frequency.

The automatic switchboard equipment of the Alouette plant was supplied by the Canadian General Electric Company, and two of its engineers were in attendance when the plant first commenced operation. The construction work was carried out under the super-

Fig. 1—Alouette plant contains one 12,500-hp. unit, which is automatically controlled

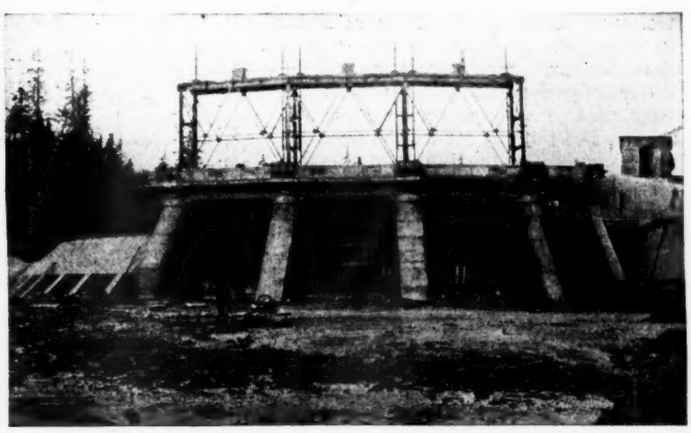


Fig. 2—Dam at Alouette Lake diverts the water through a tunnel to the plant about one mile below

vision of E. E. Carpenter, construction engineer of the British Columbia Electric Railway Company, while the actual work at Alouette was under the supervision of H. Irvine, resident engineer. This new power plant and development is but a small portion of the large hydro-electric development which is operated by the British Columbia Electric Railway Company in British Columbia.

American Engineering Council Opposes Boulder Dam

Opposition to the Boulder Dam project is declared by a special committee appointed by the American Engineering Council to examine the question from an engineering point of view. The committee, of which Francis Lee Stuart, of New York, is chairman, says in its report, made public by the president of the Council, Arthur W. Berresford:

"It is unanimously agreed that the information set forth in the reports which have been submitted to us is not conclusive as to the engineering feasibility of the plan outlined in the Swing-Johnson bill and that before either the government or private capital would be justified on engineering or economic grounds in committing themselves to the expenditure involved, the development of the river for the purpose in view should be further and most thoroughly investigated to determine how the results which it seeks to accomplish can be secured with a reasonable assurance of success."

In discussing the Boulder Dam proposition, Mr. Stuart advised the Council that "to build such an unprecedentedly high dam in the canyon section would be an unnecessarily adventurous use of government funds until the rate of filling up by flood-deposited material back of any dam in the canyon can be forecast by several years' experimentation under flood conditions with a full-sized, comparatively inexpensive power dam whose usefulness for power alone would not be destroyed by the expected filling up."

Prudence would dictate, instead of a single high dam at Boulder or Black Canyon, as a first effort in using the Colorado River, the building of a dam in the Coastal Plain to take care of flood control and regulation of low water irrigation needs, and a reasonably sized dam to make power in the canyon section and thereby secure the necessary experience as to the filling of the storages to be expected.

Owing to the fact that the question has interstate and international aspects, and that there must be a continual conflict between the use of water for flood prevention, drought and irrigation purposes, desilting, domestic use, and the generation of power, Mr. Stuart is strongly of the opinion that the matter should not be left to private interests, but should be under the control of the federal government for all such purposes, to the fullest extent that does not confiscate state rights.

National Oil and Gas Power Meeting Promises Much of Interest

To be held at Pennsylvania State College June 14, 15, 16

THE First National Meeting of the Oil and Gas Power Division will be held June 14, 15, 16, in conjunction with the Second Annual Oil Power Conference of the Pennsylvania State College at State College, Pa.

The Pennsylvania State College is situated in the beautiful Nittany Valley at an elevation of 1,200 ft. above sea level. To the east lie the Seven Mountains, to the west the Bald Eagles and the Alleghenies. Situated near the center of the State, it is readily reached by automobile.

Those traveling by train should buy tickets either to Bellefonte or to Tyrone, from both of which points good bus service is maintained.

The local committee on arrangements has completed preparations to accommodate 400 visitors in the college dormitories and dining rooms.

An interesting program is arranged for the ladies, many of whom are expected. A tea on Thursday afternoon at one of the college buildings starts their program and in the evening they are invited to the informal get-acquainted hour on the campus. For Friday an all-day automobile excursion is scheduled to the wonderful Penn's Cave and the Alan Seeger Forest Monument. Luncheon will be served in the woods. On Saturday the ladies join the men for the picnic to be held at Colerain Forge.

Oil and Gas Power Exhibition

One of the attractions of the State College meeting is the exhibition of engines and accessories. This exhibit—the first of its kind in this country—will include oil engines, parts, accessories, and equipment. A working exhibit of a new type of stroboscope, the "Stroborama," will be found very interesting. Oil spray injections reduced to 1/1000 of their real speed can be comfortably observed by a group of people with this new instrument.

Technical Program of Unusual Interest

No meeting has ever aroused the interest of oil and gas power engineers as has this meeting. The arrangement of the technical program was not left to chance nor to the selection of the contributors. It was planned more than a year ago and from the great number of interesting subjects those were selected which are particularly timely and command the widest interest. The program of the meeting follows:

Thursday, June 14, 10:30 A.M.

Address of Welcome, Dr. R. D. Hetzel, President, Pennsylvania State College.

European Diesel Engine Development, Oliver F. Allen, International General Electric Company.

Thursday, June 14, 2:00 P.M.

Chairman: Dean R. L. Sackett, School of Engineering.

The Economic Field for Small and Medium Size Diesel Engines, R. M. Reagle, Vice-President, The Bessemer Gas Engine Company.

The Economic Field for Large Diesel Engines, E. B. Pollister, General Manager, Busch-Sulzer Bros. Diesel Engine Company.

"The Diesel Engine and the Public Utilities," Roswell H. Ward, Editor, *Oil Engine Power*.

Friday, June 15, 9:00 A.M.

Chairman: Dean G. L. Wendt, School of Chemistry and Physics.

Conference on Diesel Fuel Oil Specifications.

Statement of the Problem, G. H. Michler, Standard Oil Company of New York.

Friday, June 15, 2:00 P.M.

Chairman: G. W. Lewis, Director, Aeronautical Research, National Advisory Committee for Aeronautics.

Co-operative Oil Engine Research, Harte Cooke, McIntosh & Seymour Corporation; Chairman Survey Committee, Oil and Gas Power Division A.S.M.E.

Penn State Oil Spray Research, P. H. Schweitzer, Associate Professor of Engineering Research.

Inspection of Penn State Oil Spray Apparatus in Operation.

Inspection of Engine and Accessory Exhibits.

Friday, June 15, 6:30 P.M.

Banquet—Informal, Dean R. L. Sackett, Toastmaster.

Address: Charles M. Schwab, Past President, A.S.M.E., Trustee, The Pennsylvania State College, Geo. Heath, Carels Diesel & Steam Engines, Ltd., London.

Saturday, June 16, 8:15 A.M.

Inspection of Penn State Fuel Oil Spray Apparatus in Operation.

Inspection of Engine and Accessary Exhibits.

Symposium—Specialization in Oil Engine Manufacture.

C. R. Alden, Chief Engineer Ex-Cell-O Tool and Manufacturing Company.

O. D. Treiber, President Treiber Diesel Engine Corporation.

Saturday, June 16, 3:00 P.M.

Spruce Creek—Pennsylvania State Camp, Sports—Picnic—Supper.

Export of Engines

According to the Department of Commerce, the export during February of steam engines and boilers totaled $101,396, while the total value of internal-combustion engines exported during the same month was $326,617.

A.I.E.E. Will Discuss the Mercury Boiler and Turbine at June Regional Meeting

At the Hotel Taft as headquarters in New Haven, Conn., the Northeastern District of the American Institute of Electrical Engineers will hold its fifth regional meeting May 9 to 12 inclusive. Two papers of particular interest to power engineers are "The Mercury Boiler and Turbine," by L. A. Sheldon, and "The Rocky River Development of the Connecticut Light and Power Co.," by E. J. Amberg. These papers will be presented at the Friday afternoon session.

The Rocky River Development is the first hydro-electric project in this country to pump water for power development. During the convention opportunity will be given to visit the plant and the mercury boiler and turbine installation at Hartford, Conn.

Other papers of interest to power engineers to be presented at the three days' meeting are: "Application of Wound-Type Current Transformers to High-Voltage Circuit-Breakers," by J. C. Rea; "The Diverter-Pole Generator," by E. D. Smith, Jr.; "Application of Large Frequency Changers to Power Systems," by E. J. Burnham, and "Mercury-Arc Rectifier Substations," by G. E. Wood.

Welding Progress Evident at A.W.S. Spring Meeting

Continued progress in the art of fusion welding by the gas and electric processes was made evident by papers, discussions and committee reports at the Annual Spring Meeting of the American Welding Society, held at the Engineering Societies Building, New York City, April 25, 26 and 27. This progress, it was shown, is mainly in the perfecting of technique, the establishment of preliminary standards for qualifying welders and supervising their work and the advancement of the test programs for welded pressure vessels and steel structures.

The election of the following officers for the ensuing year was announced: President, F. T. Llewellyn; senior vice-president, A. E. Gaynor; divisional vice-presidents, Ernest Lunn, J. W. Meadowcroft, H. P. Peabody; directors at large, A. M. Candy, J. H. Deppeler, E. H. Ewertz, S. W. Miller. Social affairs of the meeting included a luncheon and a highly successful stag dinner held at Keen's Chop House.

Test Data To Be Secured for Boiler Code

At a meeting of the Pressure Vessel Committee it was pointed out that the support of tank manufacturers and manufacturers of electric welding equipment is needed to insure an early start on the extensive test program to be carried on jointly by the American Welding Society and the American Society of Mechanical Engineers. These tests will supply essential data sought by the A.S.M.E. Boiler Code Committee as a basis for proposed modifications in the code for unfired pressure vessels. Gas welding interests have already pledged their support.

The meeting of the Structural Steel Welding Committee brought out the fact that funds for a similar structural research program are fully subscribed, assuring the completion of tests to establish unit stresses and other design data in this field.

"Welding Corrosion Resisting Steel Alloys" was the title of a paper by W. B. Miller, of the Union Carbide & Carbon Research Laboratories. Mr. Miller described methods of welding with the oxyacetylene torch and presented test and service results.

A preliminary progress report on qualifications of welders, inspection and supervision was presented by H. H. Moss and A. M. Candy. This covered the fields of structural steel and industrial piping and was followed by prepared discussions covering structural steel, piping and pressure vessels.

The meeting closed with a session on the welding of the new Ford car and a meeting of the American Bureau of Welding at which the progress made by various research committees of the Society was reviewed.

Coming Conventions

American Association of Engineers, annual convention, El Paso, Texas, June 4-6; M. E. McIver, secretary, 63 Adams St., Chicago.

American Boiler Manufacturers Association, annual convention, at Buckwood Inn, Shawnee-on-the-Delaware, Pa., June 11-13; A. C. Baker, secretary, 801 Rockefeller Bldg., Cleveland, Ohio.

American Institute of Electrical Engineers, annual Summer convention at Denver, Colo., June 25-29; F. L. Hutchinson, secretary, 33 West 39th St., New York City.

American Institute of Refrigeration, Washington, D. C., May 10-11.

American Order of Steam Engineers, convention at Atlantic City, N. J., June 11-14, and exhibition with American Supplymen's Association. Address Fred L. Jahn, Watson of McDaniel Company, 146 N. Seventh St., Philadelphia.

American Refractories Institute, annual meeting at White Sulphur Springs, W. Va., May 8-9; Dorothy A. Texter, secretary, 2202 Oliver Bldg., Pittsburgh.

American Society of Refrigerating Engineers, meeting at Detroit, June 4-7; W. H. Ross, secretary, 37 West 39th St., New York City.

American Society of Heating and Ventilating Engineers, Summer meeting at West Baden Springs Hotel, West Baden, Ind., June 26-29; A. V. Hutchinson, secretary, 29 West 39th St., New York City.

American Society of Mechanical Engineers, spring meeting in Pittsburgh, Pa., May 14-17; first national oil and gas power meeting at State College, Pa., June 14-16; Twin-City regional meeting at St. Paul, Aug. 27-30; Boston regional meeting, Oct. 1-3; Calvin Rice, secretary, 29 West 39th St., New York City.

American Society for Testing Materials, Atlantic City, June 25-29.

American Water Works Association. Annual meeting, Hotel Fairmont, San Francisco, June 11-16; W. M. Niesley, 170 Broadway, New York City.

Association of Iron and Steel Electrical Engineers, annual convention and Iron and Steel Exposition at Hotel Stevens, Chicago, June 25-29.

National Association of Power Engineers, annual convention at Detroit, Sept. 11-15, and concurrently National Exhibitors' Assn. exhibit; Fred Raven, 417 South Dearborn St., Chicago. New England States Association convention at Hartford, Conn., June 21-23; K. W. Lundberg, secretary. Foot Guard Armory, Hartford. New Jersey State convention at the Plaza Hotel, Journal Square, Jersey City, N. J., June 2-3; T. M. Gray, State Secretary, 46 West 51st St., Bayonne, N. J.

National Board of Boiler and Pressure Vessel Inspectors, meeting at Erie, Pa., June 18-20.

National Electric Light Association. Convention and exhibition, Atlantic City, N. J., June 4-8; A. Jackson Marshall, secretary, 420 Lexington Ave., New York City.

National District Heating Association, annual meeting at Ambassador Hotel, Atlantic City, June 12-15; D. J. Gaskill, sec., 112 West 4th St., Greenville, Ohio.

National Association Practical Refrigerating Engineers, annual convention at Louisville, Kentucky, Nov. 20-23; E. H. Fox, secretary, 5707 West Lake St., Chicago, Ill.

Stoker Manufacturers Association, fall meeting at Greenbrier Hotel, White Sulphur Springs, W. Va., Oct. 22-24.

Universal Craftsmen Council of Engineers, Newark, N. J., Aug. 7-10.

Second Bituminous Coal Conference will be held at Pittsburgh, Nov. 19-22.

National Hydraulic Laboratory Authorized by Senate

The Senate on April 13 passed the Ransdell bill, authorizing the establishment of a national hydraulic laboratory in the Bureau of Standards. A similar bill was introduced by Senator Ransdell in 1922 at the request of American Engineering Council in an effort to carry out a recommendation made by John R. Freeman. The Commerce Committee on two previous occasions reported the bill favorably and urged its passage, but it took the flood of 1927 to muster the necessary support behind the bill to insure its passage. The bill was supported strongly by Secretary Hoover. It authorizes an appropriation of $350,000.

Society Affairs

Engineering Institute of Canada, Western General Professional Meeting at Vancouver, B. C., June 7-9; R. J. Gurley, secretary, Montreal, Quebec.

A.S.M.E., Chicago Section, Palmer House, May 4, 6:30 p.m., Chicago, Ill. Speakers for the evening are Alex Dow, president of the A.S.M.E., and Dr. H. E. Howe.

American Engineering Council: Spring meeting of the Administrative Board, Milwaukee, Wis., May 10-11. May 10 will be reserved for meetings of committees, while the entire day of May 11 will be devoted to sessions of the Administrative Board.

Obituary

James J. Wood, of Fort Wayne, Ind., engineer and inventor and holder of many patents for electrical and mechanical devices, died at his home at Asheville, N. C., April 20. His age was 72. A native of Kinsale, Ireland, Mr. Wood came to the United States as a boy of eight. He started work at eleven with the Branford (Conn.) Lock Company, and at 16 designed a horizontal steam engine that won honorable mention. The four years 1874-78 were spent in Brooklyn with the Brady Manufacturing Company. From 1880 to 1885 he was a partner in the Fuller-Wood Company; thereafter for more than forty years he was associated as an inventor and consulting engineer with the Thomson-Houston and General Electric companies. Among his associates in the electrical profession he was known as the inventor of the "Wood" system and as the "father" of the closed-coil, constant-current, high-tension, series-arc dynamo. He was concerned in the manufacture of the Brayton oil engine installed in the first Holland submarine. His many patents included one for a dynamo for flood lighting, which was first used on the Statue of Liberty. He was a Fellow of the American Institute of Electrical Engineers, and a member of the Quarter Century Club of the General Electric Company.

Elias Elkan Ries, noted inventor, died of pneumonia at his home, 530 West 157th St., New York City, April 20 in his 65th year. Born in Baden, Germany, Mr. Ries was brought to this country by his parents at the age of three. He studied at Maryland Institute and Johns Hopkins. He is credited with the invention of the first practical socket for "turning down" incandescent lamps, the controller system now in use on electric elevators, the first practical self-starting electric motor and original methods in electric welding. He was a fellow of the American Association for the Advancement of Science, a member of the American Institute of Electrical Engineers, New York Electrical Society and the American Association of Inventors and Manufacturers.

Personals

Frank Brehm, formerly maintenance engineer of the Fox River Paper Company at Appleton, Wis., is now superintendent of power Marathon Paper Mills Company, Rothschild, Wis.

Dr. Michael Pupin, and John Lieb representing the A.I.E.E., and Alex Dow, representing the A.S.M.E., will attend the celebration of the centenary of the Institution of Civil Engineers of Great Britain at London the week of June 3. Mr. Lieb will also attend the dedicatory ceremonies of the new Louvain Library July 4, and the meeting of the Syndicat Professionnel de Producteurs et Distributeurs d'Energie Electrique, Paris, July 5.

Guy B. Randall has resigned as chief engineer of power with the National Cash Register Company, of Dayton, Ohio, to become superintendent of power for the Champion Coated Paper Company, of Hamilton, Ohio.

J. G. Coutant, of the Walsh & Weidner Boiler Company, sailed for Europe on the "Ille de France" April 28. He will spend a few weeks in France and England in the interests of Walsh & Weidner vertical forged-steel sectional-header boilers, and furnace water walls.

P. A. Ludwig, formerly with Welding Engineers, Incorporated, has assumed charge of Welder Service in Philadelphia and vicinity for the Lincoln Electric Company, of Cleveland, Ohio.

J. F. Duncan, manager of the Missouri Power & Light Company at Edina, Mo., for the last five years, has been transferred to Brookfield as district manager.

H. M. Brighton, formerly sales engineer with the Columbia Steel & Shafting Company, at Dayton, Ohio, was recently appointed plant engineer of the works at Pittsburgh, Pa.

A. T. Leavitt, formerly construction engineer of the By-Products Coke Ovens at Hamilton, Ontario, Canada, has been appointed president of the company.

Business Notes

Wm. W. Nugent & Company, Inc., Chicago, Ill., announce the appointment of the following Eastern and Southern sales agencies. H. W. Jones, 513 Highland Ave., Waterbury, Conn.; Dot Lubricator Company, 2401 Chestnut St., Philadelphia, Pa.; G. E. Goodman, 9612 Thorn Ave., Cleveland, Ohio; Karsten Engineering Company, 552 W. Jefferson St., Detroit, Mich.; F. H. Dorner, 548 Milwaukee St., Milwaukee, Wis.; Pittsburgh Gage & Supply Company, 30th St. and Liberty Ave., Pittsburgh, Pa.; Ben W. Lauchly, Box 271 West, Jackson, Miss.; Woodward-Wight Company, 451 Howard St., New Orleans, La.; Briggs-Weaver Machinery Company., 309-15 N. Market St., Dallas, Tex.

The Dampney Company of America, Hyde Park, Boston, Mass., announces that the sale of its "Apexior" protective coatings for power-plant equipment will be handled in southern Texas by the Maintenance Engineering Corporation, 2000 Harrington St., Houston.

The Columbus McKinnon Chain Company, Tonawanda, N. Y., has recently announced the purchase of the chain block electric hoist and crane division of the Chisholm & Moore Manufacturing Company, of Cleveland. The sales offices and plant will remain in Cleveland and will be operated as the Chisholm-Moore Hoist Company, a division of the Columbus McKinnon Chain Company. A new corporation has been organized to take over the foundry division of the Chisholm-Moore plant and will be known as the Chisholm-Moore Malleable Iron Company.

The Lincoln Electric Company, Cleveland, Ohio, announces the following changes and additions to its sales and welder service divisions: H. A. Stamper has been placed in charge of consumer motor sales in the New York district, and D. F. Titus is now in charge of welder service in the same district. A. H. Kirkpatrick replaces D. W. Carver as manager of welder service in the Cincinnati district, Mr. Carver having been transferred to the Cleveland district. H. E. Nelson, formerly with Willys Overland Company, at Toledo, now takes charge of consumer motor sales in the Cincinnati district. J. R. Rothermel is in charge of welder service

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except **Pittsburgh gas slack:**

Bituminous (Net Tons)	Market Quoting	Price per Ton
Navy Standard	New York	$2.10@$2.40
Kanawha	Columbus	1.25@ 1.60
Smokeless	Cincinnati	1.75@ 2.00
Smokeless	Chicago	2.00
S. E. Kentucky	Chicago	1.35@ 1.60
Steam	Pittsburgh	1.40@ 1.60
Gas Slack	Pittsburgh	1.00@ 1.20
Big Seam	Birmingham	1.40@ 1.75
Anthracite (Gross Tons)		
Buckwheat	New York	$3.00@$3.50
Birdseye	New York	1.60

FUEL OIL

New York—Apr. 26, industrial use, tank-car lots, 28@34 deg., Baumé, 4¾c. per gal.; 36@40 deg., 5¾c. per gal., f.o.b. Bayonne, N. J.

St. Louis—Apr. 25, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.55 per bbl.; 26@28 deg., $1.60 per bbl.; 28@30 deg., $1.65 per bbl.; 30@32 deg., $1.70 per bbl.; 32@36 deg., gas oil, 4.401c. per gal.; 38@40 deg., 4.98c. per gal.

Pittsburgh—Apr. 18, f.o.b. local refinery, 30@34 deg., fuel oil, 5¼c. per gal.; 36@40 deg., 5½c. per gal.

Philadelphia—Apr. 25, 26@30 deg., $1.90@$1.97 per bbl.; 13@19 deg., $1.15 @$1.22 per bbl.; 22 plus, $1.51@$1.58 per bbl.; 27@30 deg., $2.10@$2.17 per bbl.

Cincinnati—Apr. 24, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5c. per gal.; 26@30 deg., 5¼c. per gal.; 30@32 deg., 5.95c. per gal.

Chicago—Apr. 22, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl.; 22@26 deg., 80@85c. per bbl.; 26@30 deg., 90@95c. per bbl.; 30@32 deg., $1.05@$1.10 per bbl.

Boston—Apr. 23, tank-car lots, f.o.b. 12@14 deg. Baumé, 4.35c. per gal.; 28@ 32 deg., 5.65c. per gal.

Dallas—Apr. 21, f.o.b. local refinery, 26@30 deg., $1.40 per bbl.

at Chicago, and W. Weaver has been placed in charge of consumer motor sales in the same district.

L. J. WING MANUFACTURING COMPANY, manufacturer of forced-draft blowers, unit heaters, fans and exhausters, has moved its general offices from 352 West 13th Street to 154 West 14th Street, New York City.

THE AMERICAN FLUID MOTORS COMPANY, of Philadelphia, announces the appointment of Harry H. Leathers, 80 Federal St., Boston, Mass., as its New England representative. R. L. Sittinger will be associated with Mr. Leathers.

THE READING IRON COMPANY, Reading, Pa., announces that beginning May 1, its Chicago office will be at 1714 Engineering Building, 205 West Wacker Drive, instead of 449 Conway Building.

WAGNER ELECTRIC CORPORATION announces the removal of its New York City branch sales office from 50 Church St. to Suite 1110, 30 Church St. The New York City service station remains at 321 W. 54th Street.

THE TIMKEN ROLLER BEARING SERVICE & SALES COMPANY announces the appointment of W. H. Post as manager of the Pittsburgh branch office of the company.

TRADE CATALOGS

AIR COMPRESSORS — Ingersoll-Rand Company, 11 Broadway, New York, has just completed the sixth edition of its 140-page, two-color book entitled "100 and 1 Ways to Save Money with Portable Compressors." In this book the company has embodied comparative cost data on its portable air compressors and air-operated tools, such as rock drills, paving breakers, clay diggers, backfill tampers, grinders, hoists, riveting hammers, chippers, metal drills, etc. The information has been put together in handy reference, cross-index form. In most cases figures are presented on a man-hour basis so that they can be readily applied to local conditions in any part of the world. Free copies may be obtained by writing to Ingersoll-Rand Company, 11 Broadway, New York City, or any of its local branches in any part of the world.

COMPRESSORS AND VACUUM PUMP.—A complete and comprehensive catalog, No, 3150, has been issued by Ingersoll-Rand Company, New York City, on its class ER and FR compressors. These machines are of the straight-line type; the compressors are built in single- and multi-stage designs, for pressures up to 1,750 lb.; the vacuum pump will pull up to 28 to 29 in vacuum. All the essential parts of the machines are shown, and the many pictures of existing installations lead an additional attraction to the catalog.

CEMENT GUN, ITS USE IN POWER AND STEEL PLANTS—Cement Gun Company, Allentown, Pa., has issued a new bulletin, dated March, 1928, in which is reviewed present practice in the application of protective coatings by means of the "Gun" to boiler furnaces, stacks, coal bunkers, breechings, ash hoppers, condenser boxes, steel-mill furnaces, ladles, etc. Useful data are also included and a variety of jobs illustrated.

HIGH-TEMPERATURE CEMENT.—Those engineers who use high-temperature cement in furnace linings, but are unacquainted with the particular characteristics of the various clays, will welcome the booklet, "Choosing a High Temperature Cement," published by General Refractories Company, Philadelphia, Pa.

UNIT HEATERS—The Grinnell Company, Providence, R. I., has issued a new booklet describing its industrial-type unit heater "Thermolier." Detailed illustrations are included to show its constructional features.

NEW PLANT CONSTRUCTION

Compiled by the McGraw-Hill Business News Department, which is prepared to furnish a more complete daily service to those who wish it

Ark., McGehee — Missouri Pacific R.R., Railway Exchange Bldg., St. Louis, Mo., had plans prepared for the construction of a 40 x 70 ft. boiler house here. E. A. Hadley is chief engineer.

Calif., Sacramento — State Officials are discussing with American River Hydro Electric Co., feasibility of leasing state lands near Folsom for the construction of a flood control and power dam on the American River. Lands will be leased to the power company for period of 50 years, together with all state rights to flow of river, but company must construct adaquate flood control dam. Estimated cost approximately $10,500,000. S. E. Keiffer, is engineer for water company and E. Hyatt, is state hydraulic engineer.

Calif., San Francisco—Pacific Gas & Electric Co., 245 Market St., is receiving bids for the construction of a compressor plant on North Beach St. Estimated cost $25,000. Private plans.

Conn., Bridgeport—United Illuminating Co., 1115 Broad St., awarded contract for the construction of a power sub-station, 4,800 kw. capacity, also underground transmission line from Steel Point station to outdoor transformers for lower voltage thence to sub-station and automatic regulators to Leverty & Hurley, 500 Waterview Ave. Estimated cost to exceed $40,000.

D. C., Benning (Washington P. O.)—Potomac Electric Power Co., plans an addition to power plant on Benning Rd. near Anacostia River. Estimated cost $300,000. Stone & Webster, 147 Milk St., Boston, Mass., are engineers and contractors.

La., Logansport—City voted $32,000 bonds for the construction of municipal light and power plant.

Md., Baltimore—C. Hoffberger Co., H. Hoffberger, Pres., Gay and Oliver Sts., will soon award contract for a cold storage plant and warehouse at 538 East Monument St. Estimated cost $700,000. J. H. Wickersham, Lancaster, Pa., is engineer.

Massachusetts—Boston, Revere Beach & Lynn R.R., 350 Atlantic Ave., Boston, plans electrification of railroad from Boston to Lynn including Winthrop Loop. Plans include a sub-station at Orient Heights. Estimated cost $55,000. N. M. Powell is chief engineer. Work will be done by day labor.

Mass., Boston—Dept. of Public Buildings, awarded contract for the construction of a power house and heating plant at Charles St. jail to J. E. Dyer, 334 Common St., Belmont. Estimated cost $82,282.

Mass., Boston—Penal Institutions Dept., awarded contract for the construction of a power house and heating plant at Deer Island, Boston Harbor to J. Bowen Co., 184 Dudley St., Roxbury. Estimated cost $200,000.

Mass., Boston—United Shoe Machinery Co., 205 Lincoln St., Boston, will receive bids May 1 for a 14 story office building on Federal St. Parker, Thomas & Rice, 177 State St., are architects. French & Hubbard, 210 South St., are engineers.

Mass., Dorchester (Boston P. O.)—Boston Ice Co., 110 State St., Boston, is receiving bids for the construction of an ice plant at Dewar and Aukland Sts. here.

Mass., Foxboro—Dept. of Mental Diseases, is having plans prepared for the reconstruction of boiler house at State Hospital. Estimated cost $40,000.

Mass., Lynn—North Shore Ice Co., 46 Lynn Ave., will build an ice plant on Boston St. Estimated cost to exceed $40,000. York Ice Machinery Corp., 200 Causeway St., Boston, is engineer.

Mass., Marlboro—R. S. Davenport, Prospect St., Framingham, awarded contract for boiler house, etc. to King Construction Co., North Tonawanda, N. Y. Estimated cost $40,000.

Mass., Marshfield—Bd. of Water Comrs., awarded contract for the construction of a pumping station to F. A. Mazzur Co. Inc., 141 Milk St. Boston. Estimated cost $25,240.

Mass., Wellesley (Boston P. O.)—City awarded contract for the construction of a pumping station to J. E. Palmer, 294 Washington St., Boston. Estimated cost $25,000.

Mass., Winchester—Arlington Gas Light Co., 689 Massachusetts Ave., Arlington, awarded contract for the construction of a heater and governor house on Cross St. here to F. Losardo, 35 George St., Hyde Park. Estimated cost $25,000.

Mich., Detroit—Adcraft Club, R. Herrick, 2111 Woodward Ave., is having plans prepared for a 22 story office building including steam heating and ventilation systems, boilers, elevators, etc. on Bagley Ave. Estimated cost $1,750,000. Architect not announced.

Mich., Detroit—Bd. of Water Comrs., 176 East Jefferson Ave., awarded contract for a 20 story office building on Bates St. to A. W. Kutsche, 2111 Woodward Ave. Estimated cost $1,600,000. Steam heating, systems, boilers, elevators, etc. will be installed.

Mich., Detroit—Gladwin Park Realty Co., 724 Book Bldg., is having plans prepared for twelve 8 or 10 story apartment buildings including steam heating and ventilation systems, boilers, elevators, etc. on Jefferson Ave. Estimated cost $5,000,000. Architect not announced.

Mich., Detroit—A. Kahn, 1000 Marquette Bldg., Archt., will receive bids about May 8 for a 15 story office buldiing including steam heating and ventilation systems, boilers, elevators, etc. on Griswold St. for Griswold Amusement Co., 1313 Dime Bank Bldg.

Mich., Grand Rapids—Grand Rapids Gas & Light Co., 47 North Division St., is having preliminary plans prepared for the construction of a booster plant to replace plant destroyed by explosion on Wealthy St. Estimated cost $75,000.

Mo., St. Louis—Owner, c/o Pleitch & Price, 1592 Arcade Bldg., Archts., awarded contract for a 15 story apartment building at 3745 Lindell St., to Selden-Breck Construction Co., 1108 Fullerton Bldg. Estimated cost $1,000,000.

Mo., St. Louis—Syndicate, c/o Hermann-Mayer Co., 3617 South Grand Blvd., will build an 8 story apartment building including vapor steam heating, and electric refrigeration systems, elevators, etc., at Grand and Russell Blvds. Estimated cost

$575,000. R. E. Tisdale, 3617 South Grand Blvd., is architect. Work will be done by separate contracts.

New Jersey — Delaware, Lackawanna & Western R.R., 90 West St., New York, plans electrification of Morris and Essex line from Hoboken to Dover, also the Passaic and Delaware to Gladstone and the Montclair branch. Estimated cost approximately $14,000,000. G. J. Ray, Hoboken, is chief engineer.

N. J., Bloomfield—Bd. of Commissioners, Essex Bldg., will receive bids until May 7 for the construction of a boiler house on Franklin St. Estimated cost $40,000.

N. J., Jersey City—Public Service Electric & Gas Co., 80 Park Pl., Newark, plans the construction of a transformer sub-station at Sip St. and Whitman Ave. Estimated cost $40,000. Public Service Production Co., 80 Park Pl., Newark, is architect and engineer.

N. J., Newark—Five Hundred Twenty Three Mount Prospect Ave. Corp., Prudential Bldg., awarded contract for an 8 story apartment building to W. J. MacEvoy Construction Co., 85 Academy St. Estimated cost $500,000. Steam heating system, etc. will be installed.

N. J., New Brunswick—New Brunswick Hotel Corp., J. E. Mitchell, Pres., 362 George St., awarded contract for a 10 story hotel, stores and fur storage plant at Livingston Ave. and Schureman St. to Ward Co., 1600 Walnut St., Philadelphia, Pa. Estimated cost $700,000. Steam heating, ventilation and refrigeration systems, boilers, elevators, etc. will be installed.

N. J., Rahway—Rahway Memorial Hospital, F. W. Kedd Pres., 81 Jaques Ave., will soon award contract for a hospital including steam heating, ventilation and refrigeration systems, boilers, etc. at Stone St. and Jefferson Ave. Estimated cost $500,000. Crow, Lewis & Week, 200 5th Ave., New York, N. Y., are architects.

N. J., South Orange—Public Service Electric & Gas Co., 80 Park Pl., Newark, awarded contract for the construction of an electric substation on Fourth St. here to Public Service Production Co., 80 Park Pl., Newark. Estimated cost $60,000.

N. Y., Brentwood—Dept. of Mental Hygiene, Albany, is having preliminary plans prepared for the construction of two hospital buildings including heating plant, etc. here. Estimated cost $1,500,000.

N. Y., Elmira—Wisner Park Corp., c/o J. J. Hassett, State Theatre Bldg., awarded contract for an 8 story hotel at Main and Gray Sts. to Lowman Construction Co., 312 Railroad Ave. Estimated cost $1,000,000.

N. Y., Far Rockaway—Queens Borough Gas & Electric Co. plans to vote $4,000,000 bonds for extensions and improvements to power station, transmission lines, etc.

N. Y., Morristown—Village, E. A. Spillman, Clk., will receive bids until May 16 for improvements to waterworks including pumping station, etc. W. T. Field, Watertown, is consulting engineer.

N. Y., New York—Fur Merchants Warehouse Corp., D. Nickelsburg, Pres., 238 West 28th St., had plans prepared for additions to cold storage plant and warehouse at 240 West 28th St. Estimated cost $200,000. B. Grundlach, 597 5th Ave., is architect.

N. Y., New York — Electrical Tesitng Laboratories, 10-16 East End Ave., had plans prepared for a 9 story office building. Estimated cost $1,600,000. Thomas E. Murray Inc., 55 Duane St., is engineer.

N. Y., New York—Garment Center Capitol Co., S. Singer, Pres., 498 7th Ave., had plans prepared for a 43 story office building, etc. at 38th St. and 7th Ave. Estimated cost $4,000,000. Sugarman & Berger, 345 Madison Ave., are architects.

N. C., Henderson—Roanoke River Power Co., Richmond, Va., has been granted permit to construct a hydro-electric power development on the Roanoke River near Briggs Island, 20 mi. north of Henderson to develop 70,200 hp. Plans include a dam, 80 ft. high, and 60 mi. transmission line to connect with Appalachian Power Co. at Danville, Va.

N. C., Raleigh—E. L. and A. R. Henderson, Burlington, plans to erect and equip a large ice plant here.

O., Cleveland—The Cleveland Electric Illuminating Co., Illuminating Bldg., will soon award contract for addition to electric sub-station at 13100 Woodland Ave. Estimated cost $40,000. Private plans.

O., Columbus—City will receive bids about Aug. 1 for a 5 story safety building including central heating plant, etc. on West Gay St. Estimated cost $650,000. Allied Architects Association of Columbus, 82 West Broad St., is architect.

Okla., Marshall—City awarded contract for waterworks improvements including dam, filter plant, pumps, motors, etc., to Sherman Iron Works, 18 East Main St., Oklahoma City. Estimated cost $35,000.

Pa., Philadelphia—One Thousand Twelve Spruce St. Corp., J. J. McDevitt, Pres., c/o Ritter & Shay, Packard Bldg., Archts., awarded contract for a 27 story apartment building at 1512 Spruce St. to Murphy Quigley & Co., 1524 Sansom St. Estimated cost $3,300,000.

S. D., Sioux Falls—City defeated $100,000 bond election Apr. 17 for extensions and improvements to electric light plant.

Tenn., Cookeville—Bd. of Education, P. L. Harned, Comr., State Capitol, Nashville, will readvertise for bids soon for the construction of a power plant, etc. for Tennessee Polytechnic Institute here. Estimated cost $165,000.

Tex., El Paso—Pasotex Petroleum Co. is having plans prepared for the construction of three booster stations between El Paso and Winkler county. Estimated cost $150,000. Private plans.

Wis., Milwaukee—Herbst & Kuenzli, 130 Wisconsin Ave., Archts., will receive bids until May 3 for the construction of a college including power house, etc. at Burleigh St. and Swan Rd. for St. Marys College, School Sisters of Notre Dame, 676 Milwaukee St.

Wis., Randolph—City plans an election soon to vote $48,000 bonds for the construction of a municipal electric light plant, including boiler, two new generators, switches, etc.

Ontario — Hydro Electric Power Commission, 190 University Ave., Toronto, estimates for extensions, transformer stations, distribution systems, transmission lines, etc., in connection with power system. Niagara System, $400,000. Georgian Bay System, $75,000, Ottawa and St. Lawrence Systems, $1,600,000. Central Ontario System, $365,000. Nipissing System, $20,000, and Saulte Ste Marie System, $10,000. Total cost $2,470,000. F. A. Gaby, 190 University Ave., Toronto, is chief engineer.

Ont., Hamilton—Toronto Hamilton Buffalo Railway, is having plans prepared for the construction of a power house, locomotive repair shops, roundhouse, etc. Estimated cost $1,000,000. H. T. Malcolmson, is engineer.

Ont., Simcoe—Lake Simcoe Ice Co., awarded contract for addition ice plant to Carswell Construction Co. Ltd., C. P. R. Bldg., Toronto. Estimated cost $80,000.

Equipment Wanted

Air Compressor—City of Muskegon, I. L. Christiansen, Clk., City Hall, will receive bids until May 11 for a portable air compressor.

Air Compressor — Village Board, Shorewood, Wis., will receive bids until May 7 for one 110 cu.ft. portable gas driven air compressor mounted on coat steel frame.

Boiler and Motor—M. Gamache, 1647 Visitation St., Montreal, Que., plans to purchase a 35 hp. boiler and 5 hp. electric motor.

Boiler, Generators, Switchboards, etc.—City of Randolph, Wis., plans to purchase a boiler, two new generators, switchboards, etc., for proposed electric light plant.

Boilers, Motors, Etc.—C. T. A. Hart, 796 St. Catharine St. W., Montreal, Que., plans to purchase two 50 hp. steam boilers and three 9 hp. electric motors for auto repair shop.

Boilers, Generators, Oil Burners, etc. — Missouri Pacific R.R., Railway Exchange Bldg., St. Louis, Mo., plans the installation of 250 hp. boilers, two electric generators, oil burners, etc., in proposed new boiler house at McGehee, Ark.

Engines — Pasotex Petroleum Co., El Paso, Tex., plans the installation of Diesel engines in proposed booster stations.

Engines, etc.—Beebe Bros., Wallaceburg, Ont., prices and catalogs on marine engines, etc., for boat building plant recently destroyed by fire.

Pumping Equipment—City of Guymon, Okla., plans to purchase pumping equipment, etc. for proposed waterworks improvements. Estimated cost $20,000.

Smoke Breeching — Borough of Etna, Pittsburgh, Pa., J. Armstrong, Clk., will receive bids until May 14 for the design, construction, erection and testing of a smoke breeching with connections to three boilers and attachments to existing stack.

Refrigeration Plant, etc.—Laney Creamery Co., J. C. Laney, 104 East Josephine St., San Antonio, Tex., plans to purchase new equipment including model refrigeration plant with storage capacity of 4 car loads of butter, etc., for proposed creamery.

Industrial Projects

Ala., Woodward — COKE HANDLING SYSTEM—The Woodward Iron Co. awarded contract for the construction of a complete new Semet-Solvay coke handling system including wharf, screening and loading plant, etc., to Semet-Solvey Engineering Co., 61 Broadway, New York, N. Y.

Calif., Linden—PACKING PLANT—A. C. Martin, Higgins Bldg., Los Angeles, Archt., is receiving bids for a 1 story, 80 x 120 ft. plant here, for San Joaquin Valley Walnut Growers' Assn., c/o architect.

Calif., Los Angeles — PHONOGRAPH RECORD FACTORY — Brunswick-Balke Collendar Co., 855 South Los Angeles St., will soon award contract for a factory, warehouse, finishing and drying rooms, etc., on Mines Ave. Krempel and Erkes, Bank of Italy Bldg., are architects.

Calif., San Francisco—PRODUCE TERMINAL—San Francisco Produce & Provision Terminals, Financial Center Bldg., is having preliminary plans prepared for the construction of produce terminal buildings at Laguna, Beach and Webster Sts. and Marina Blvd. Estimated cost $3,000,000.

Ill., East St. Louis — RUBBER RECLAIMING PLANT—Midwest Rubber Reclaiming Co., c/o Akron Rubber Reclaiming Co., Norton Ave., Akron, awarded contract for a 1 story plant, 25 ton daily capacity, at Monsanto Village near here, to The Austin Co., 16112 Euclid Ave., Cleveland, O. Estimated cost $150,000.

Ill., Moline — ELECTRIC FLASHER FACTORY — Harrington-Seaberg Co. awarded contract for a 4 story, 62 x 135 ft. factory for the manufacture of police and fire alarm equipment, traffic signals and electric flashers, etc. Estimated cost $75,000. A second unit will be built later.

Mich., Detroit—CHEMICAL FACTORY—National Pharmical Co., 5429 Dix Ave., awarded contract for a 1 and 2 story, 60 x 146 ft. factory on Scotten Ave. to A. R. Yops, 7411 Grand River Ave. Estimated cost $45,000.

Mich., Flint—SPARK PLUG FACTORY—A. C. Spark Plug Co. awarded contract for a 3 story factory for addition to ceramic department on South Saginaw St., to W. E. Wood Co., 1805 Ford Bldg., Detroit. Estimated cost $40,000.

N. J., Jersey City — ELECTRIC MACHINERY FACTORY—H. E. Salzberg & Co., Inc., 54 Brook St., is having plans prepared for a 1 story, 50 x 214 ft. factory for the manufacture of electric machinery at Water and Clark Sts. Estimated cost $50,000. Private plans.

O., Bedford—BRONZE POWDER FACTORY—Aluminum Bronze Powder Co., P. J. Steigerwald, 1823 Columbus Rd., Cleveland, awarded contract for a 1 story, 36 x 80 ft. factory, here, to R. E. Nixon, 10006 Carnegie Ave. Estimated cost $40,000.

Pa., Ambridge—BEAM PLANT ADDITION—American Bridge Co., Frick Bldg., Pittsburgh, will build addition to beam plant here. Estimated cost $1,000,000. Private plans.

Pa., Brookville — CREAMERY — Harmony Creamery Co., 407 Liberty St., Pittsburgh, awarded contract for a 1 and 2 story creamery here to J. H. Carr, Brookville. Estimated cost $40,000.

Pa., Philadlephia — MACHINERY FACTORY—Acme Coppersmiths & Machinery Co., J. Epstein, 1024 Ridge Ave., will build a 4 story, 109 x 240 ft. factory at Berks and Hancock Sts. Private plans. Work will be done by separate contracts.

Pa., Philadelphia—CANDY FACTORY—C. A. Asher, 5606 Germantown Ave., awarded contract for a 4 story, 51 x 52 ft. factory to William Steele & Sons Co., 15th and Cherry Sts. Estimated cost $65,000.

Pa., Philadelphia—LEATHER FACTORY—England Walton Co. Inc., Third and Vine Sts., awarded contract for a 7 story, 41 x 63 ft. factory to W. Steele & Sons Co., 121 North 15th St. Estimated cost $60,000.

Pa., Pittsburgh—SAW TRIMMER FACTORY—Miller Saw Trimmer Co., Point Bldg., will soon award contract for a 1 and 2 story, 261 x 293 ft. factory. Estimated cost $300,000. Hunting, Davis & Dunnells, Century Bldg., are architects.

Tenn., Memphis — DAIRY — Forest Hill Dairy, 1647 Union St., will soon award contract for a 2 story, 65 x 130 ft. dairy at Madison Ave. and East End Park. Estimated cost $150,000. W. R. Nelson, Shrine Bldg., is architect.